TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. X No. 1. JANUARY, 1933. PRICE 6d.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183.

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THE RISE OF GENETICS.

THE Sixth International Congress of Genetics which was held recently at Cornell University, Ithaca, New York, was characterised by a very stimulating Presidential address on "The Rise of Genetics", delivered by Professor T. H. Morgan. Genetics, he said, began with the resurrection of Mendel's paper in 1900. Similar experiments by de Vries, Correns, and Tschermak in that year had led to conclusions identical with those of Mendel, and to the discovery of Mendel's forgotten paper. Since that time the attention of hundreds of biologists has been devoted to the development of the science of genetics and with the discovery that the same laws applied to other plants, to animals, and even to man himself, came the realisation that a great step forward had been made. As Bateson said, "the experiments which led to this advance in knowledge are worthy to rank with those that laid the foundation of the atomic laws of chemistry".

The labours of earlier workers must, however, not be forgotten. Between the discovery of sex in plants by Camerarius in 1694 and the production of the first plant hybrid by Fairchild, twenty-five years elapsed, and it was not until 1760 that the scientific study of hybridisation was begun by Kohlreuter. In the early years of the 19th century a group of English workers, Goss, Seton, and Knight were recording some of the facts upon which Mendel's studies with garden peas rested. In 1861-64 we find Naudin, the French botanist, working on a large number of plant hybrids. It is sometimes stated that Naudin anticipated Mendel's discoveries. It is true that he emphasised the identity of individuals of the first generation hybrids, including reciprocal crosses. He also stated definitely that in the second and later generations there occurred a mixture of forms, some like the original parents and others that resembled them in varying degree. His most important conclusion was that the results of the second generation could be explained on the assumption that in the pollen and ovules of the hybrid, occurred a *disjunction of the two specific essences derived from the parents*. This was a highly significant contribution, for not only did Naudin see clearly that the results are explicable on the principle of disjunction (or as we say now, segregation), but that this, taking place in both the egg and in the pollen, gives the kind of characters that appear. Naudin's work fell short of that of Mendel in some important particulars. He did not put the hypothesis to the test by back-crossing, nor did

he predict what the numerical results should be on the basis of disjunction in the hybrids. The outstanding feature of Mendel's work was his recognition of the orderly results of segregation, and the clearness with which he stated and verified the interrelation between character pairs in inheritance, when more than one character pair was involved.

The study of animals played little part in the pre-Mendelian history of genetics. Zoologists were familiar with animal hybrids, and much of the scattered information available was collected by Darwin in his monumental "Animals and plants under Domestication". But in the latter half of the 19th century much work was being done in cellular morphology and cytology, thus paving the way towards the recognition of the chromosome mechanism which was to provide a foundation for the known field of Mendelian phenomena.

It was hardly to be expected that botanists and zoologists would be satisfied with a mathematical formulation of the facts of segregation and independent assortment of characters, and it was not long before Sutton in 1902 pointed out that the behaviour of the chromosomes—by then fully worked out, supplied the necessary cellular mechanism to account for Mendel's results. Since 1900 other principles have been added to the two fundamental principles discovered by Mendel. These are linkage, the linear order of the genes along the chromosomes, interference, and the limitations of the linkage groups. Much of the quantitative work in genetics has concerned itself with the discovery of genes in various organisms and their localisation in the chromosomes. It has been shown that interchanges of chromosomal material take place only between homologous chromosomes, *i.e.*, between members of the same pair, and that when interchange takes place, large blocks of the chromosomes are interchanged. Until recently the evidence that large blocks of genes are involved in crossing over was known only genetically, and no certain cytological proof was known. In both plants and animals the cytological proof has now been found. The discovery that not only mutations but also various types of chromosomal aberrations could result from treatment of plants and animals with X-rays has led to the initiation of a fruitful series of researches, particularly in connection with studies of the redistribution of the linkage group by translocation.

In recent years much work has been done on the numerous problems connected with increase in number of the chromosomes—the phenomenon of polyploidy. It is difficult to summarise the vast output of research on this, to the plant breeder, an important subject. In many families of plants a series of chromosome numbers are present which are multiples of a basal number, usually of the haploid number of the lowest member, of the group. A good many of our cultivated plants possess multiples of a basal number of chromosomes, *e.g.*, wheat, banana, sugar-cane, cotton. It is difficult to avoid the conclusion that a primitive chromosome number has been doubled. There are two ways in which this can happen. The first is by doubling of the chromosome number in the somatic tissue and the second by the formation of gametes containing either the unreduced number of chromosomes, or more than the haploid complement of chromosomes. Doubling of diploids gives tetraploids, and these crossed to diploids give triploids. Many triploid and tetraploid forms represent a considerable advance in economic properties upon the diploid. For example the cultivated bananas are polyploids, no doubt derived from the primitive seeded forms, and the product of New World cottons with 26 chromosomes is superior to that of the Old World cottons with 13 chromosomes.

Besides cases where the chromosome number undergoes multiplication in the same group, a few are known in which an increase has occurred as a result of irregular meioses in the parents of crosses of distinct species with the same or different numbers of chromosomes. Abnormalities in gametogenesis resulting in polyploid gametes can be grouped according to Darlington under four heads. On crossing the radish, *Raphanus sativus*, (2n=18) with the cabbage, *Brassica oleracea*, (2n = 18) Karpechenko obtained mostly sterile hybrids with 18 somatic chromosomes, *which were sterile*. The F2 progeny consisted mainly of tetraploids, (2n=36). These breed true to the new chromosome number and constitute a new kind of plant, *Raphanobrassica*, which is neither cabbage nor radish. Randolph has lately shown that the production of polyploids in maize can result from the application of heat at a critical time to the fertilized embryos. This method is full of significance for the fruit breeder and it may be said in general that the artificial production of polyploids offers a wide and unexplored territory for both the geneticist and plant breeder, for it is one of the ways in which a new fertile compound of a wild and cultivated species can be made.

Besides its influence on the development and subsequent history of the chromosome hypothesis, the study of zoology resulted in a vast body of knowledge in the field of experimental embryology. Although the observations made were mostly quantitative, some facts emerged which are probably of fundamental importance for genetics, since for example an experimental demonstration was provided that the factors concened in the differentiation of the embryo are present in the cytoplasm at the time of their activity.

From the layman's point of view, perhaps the most spectacular discovery in genetics of the last 30 years is that concerning the genetic basis for the determination of sex in animals—a discovery which incidentally consigned to the limbo, the extravagant claims of those who professed to be able to pre-determine the sex of animals. The sex mechanism is now capable of exact formulation in terms of chromosome behaviour throughout

the animal kingdom, and an extension of this knowledge is now being made to dioecious plants. There has, however, been some change in outlook on the idea of sex from the genetic point of view. It was at first supposed that in Drosophila one X chromosome and one Y chromosome made a male, and that two X chromosomes made a female. The sex chromosome itself was believed to be the differential of sex. This hypothesis gave way to another which postulated that the sex chromosome was the carrier of a gene, or genes for sex. Attempts to locate such a gene or genes have proved unsuccessful and the present tendency is to look upon many genes as sex determining. This view embodies the probability that certain genes have more influence than others in sex-determination. The theory that characters such as sex, are due to a balance between the intercellular products of genes is, according to Professor Morgan, "the most direct contribution to physiology that modern genetics has made".

Professor Morgan devoted the final part of his address to the bearing of genetics on the theory of evolution. To those who have followed the recent contributions of R. A. Fisher to this important question, put forward in his book "The Genetical Theory of Natural Selection", it is evident that as was the case with the re-discovery of Mendelism—a great step forward in biology has been made. It is therefore perhaps a little surprising that Professor Morgan should have made no allusion to the change in outlook which must result from the experimental verification of the Fisher dominance hypothesis. No doubt, however, it is still wise to be conservative and cautious.

In his closing remarks, Professor Morgan stated what seemed to him to be the most important problems for genetics in the immediate future. The final problem is of special interest to workers on genetics in the Tropics: "the application of genetics to horticulture and to animal husbandry, and the incorporation of genes from wild varieties and species into strains of domesticated types".

It must be admitted that the practical applications of modern genetic theory to plant breeding have mostly been made in countries outside the Tropics. Perhaps the American work on maize has been so far the most productive of practical results, since the breeding of maize in that country has been subject to constant inspiration from genetics. It is, at all events significant that the most fruitful advances in breeding technique have been made upon a crop which has been at the same time studied in most detail by geneticists.

CACAO LITERATURE.

Copies of Professor Cheesman's paper on the "Economic Botany of Cacao" may be obtained on application to the Editor of this Journal. Price 1s. each.

OBITUARY.

William Scott Herriot, A.M.I.C.E., M.I.M.E.

It is with deep regret that we have learnt of the death of Mr. Scott Herriot on 15th November, 1932, at his residence in Pollockshields, Glasgow. He was one of the original Governors of this College, a position which he held until his death. Mr. Herriot, as a Director of the Mirrlees Watson Company, Ltd., and as the holder of many other important public posts was a prominent figure in the sugar world. His interests lay chiefly in sugar engineering of which he had an exceptional knowledge, gathered from his experiences as a factories' engineer in British Guiana and from his extensive travels in the American sugar producing countries, and in Java, India and Mauritius. From this wide experience he became firmly convinced of the need for the provision of adequate training facilities to maintain up-to-date methods of production in sugar factories and it was largely through him that sugar manufacture classes were initiated at the Royal Technical College, Glasgow.

When he became Governor of the College he saw further opportunities for pressing his educational views and it was mainly through his efforts and those of the late Sir Francis Watts that a course in Sugar Technology was provided for, and an Instructional and Experimental Sugar Factory built. Herriot's especial care was the equipment of this Factory and, as Chairman of the British Empire Sugar Manufacturers' Association, he exercised a decisive influence in securing practically the whole of the machinery that it contains as a gift from associated firms. Herriot's services to the College will thus be chiefly remembered in connection with the Department of Sugar Technology which he helped materially to create. His demise is a very severe loss to the College.

Our deepest sympathy and condolences are extended to his family.

TWO NEW REPORTS.

Copies of the following Reports which have just been published may now be obtained from the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I. Price 1s. each.

1. The First Annual Report of the Cacao Research Scheme (1931) 44 pp., twelve diagrams and one plate.

2. The Cacao Soils of Grenada by F. Hardy, J. A. Macdonald and G. Rodriguez. 28 pp. and two maps.

MUTANT TYPES OF THE DWARF BANANA.

By E. E. Cheesman.

The banana referred botanically to *Musa Cavendishii*, and variously known as the Dwarf, Chinese, Cavendish or Canary, and by many other and more local names in different parts of the world, is a distinct type with characteristics that render it an invaluable commercial variety in places where its taller relatives will not thrive. Thus interest is at present being shown in the extension of its cultivation in more than one country, and has prompted botanical studies to ascertain whether the dwarf banana is everywhere the same, although widely distributed, or whether sub-types or local races occur within it.

Such studies are in progress at the Imperial College of Tropical Agriculture, where already the commercial dwarf bananas of the Canary Islands and of Brazil are growing alongside collections from several stations in the West Indies, for minute comparison. Further collections are being made by the Kew authorities in the East, and some time must elapse before the comparisons are complete. At the present stage it would be premature to discuss the main question of identity.

Meanwhile, however, an interesting side-line has opened from the main investigation. An accumulation of evidence favours the view that the ordinary dwarf banana (assuming it for the present to be a single type) has more than once in its agricultural history thrown bud sports. Some of these sports are sufficiently like the type to be recognized at once for what they are, whilst others of apparently similar origin are so different as to pass for new varieties. The evidence is drawn from several sources, and the purpose of this note is to summarise it.

The first item is provided by Fawcett in his well-known book on the banana (1), where he mentions receiving from Dr. G. V. Perez of Teneriffe specimens of a sport of the Canary banana "about double or treble the height of the ordinary dwarf kind". He adds: "This sport appears here and there in the plantations without apparent cause, and is called by the natives the 'male' banana. Suckers grow up like the parent sport. It is possible that many or all of these tall bananas are from suckers of the original sport, which have been planted inadvertently with the ordinary kind, but there is no explanation of the first appearance." No mention is made of any other character differentiating this sport from its parent type, except its remarkably tall stem.

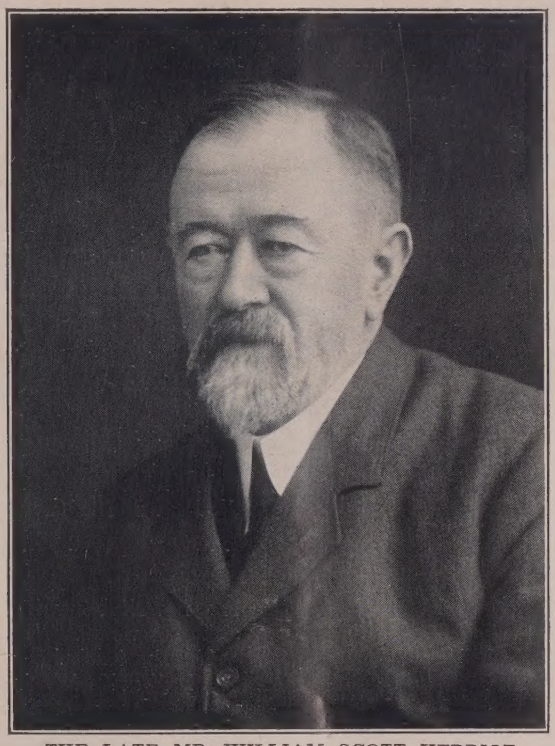
The next item is drawn from the Imperial College of Tropical Agriculture banana collection. In 1927 the College received from the quarantine house at Kew a number of bananas originally collected and grown in the Botanic Gardens, Orotava, Teneriffe, by Senor Bolinaga. Among them were three plants labelled *M. Cavendishii*, two of them obvious mutants of the ordinary dwarf type, and equally obviously of no commercial value, but of scientific interest as illustrations of the occurrence of mutation in this line. One, which may be called Canary Mutant No. 1, seems to differ from the type in nothing but a tendency to dichotomy of the bud. Quite frequently it produces two bunches from one pseudostem, and (fig. 1) illustrates a stool in which its branching tendencies are extremely developed. In the case illustrated, one dichotomy occurred whilst leaves were still differentiating so that there are two pseudostems in one, both being surrounded by the sheaths of the lower leaves, formed before the bud divided. From the pseudostem to the right of the photograph there appeared in due course an inflorescence bud, which developed a simple bunch. The axis of the pseudostem on the left forked again just before the transition from foliage leaves to inflorescence, giving twin bunches, and the left hand bunch of these two later underwent a third dichotomy just below the second hand, and hence possesses two "hearts" or male buds.

Canary Mutant No. 2 (fig. 2) is another freak plant, characterised by being still more dwarf than the normal type and by a consistent failure to "shoot" its bunch properly.

The third plant from the Orotava collection is more interesting in its bearing on the economic side of the question under discussion. It was labelled "*Musa Cavendishii var. Bolinaga No. 4*", but when in due course it flowered and fruited it proved to be quite distinct from *M. Cavendishii* as ordinarily understood. In habit it is taller than the Canary type, though not so tall as the general run of tall varieties. But the characteristic which most strikingly differentiates it from its supposed parent is that it sheds all its male flowers with their subtending bracts soon after they have opened, leaving the rachis clean and naked. This feature is, of course, common to the majority of banana varieties, and the opposite character of holding the faded bracts and male flowers on the rachis throughout the period of maturation of the bunch is, next to its dwarf stature, the most striking feature of the ordinary Cavendish type.

So great is the change in general appearance caused by these two characters, increase in height and shedding of bracts, that from the outset grave doubt was felt of the accuracy of the ascription of "Bolinaga No. 4" to *M. Cavendishii*. Nevertheless, prolonged observation of its fruit characters and general behaviour, including its failure, in common with that of the dwarf banana, to set any seed in pollination experiments, led finally to recognition of the fact that the differences in question are by no means fundamental, and that this plant may very well be a vegetative sport of the dwarf.

Further evidence of the occurrence of "sports" in the Canary Islands has been advanced by Mr. H. C. Sampson, Economic Botanist at Kew, who in the early part of 1931 visited Teneriffe



THE LATE MR. WILLIAM SCOTT HERRIOT

MUTANT TYPES OF THE DWARF BANANA.

FIG. 1.—*Canary Mutant No. 1.*

FIG. 2.—*Canary Mutant No. 2.*

BANANA DISEASES—V.

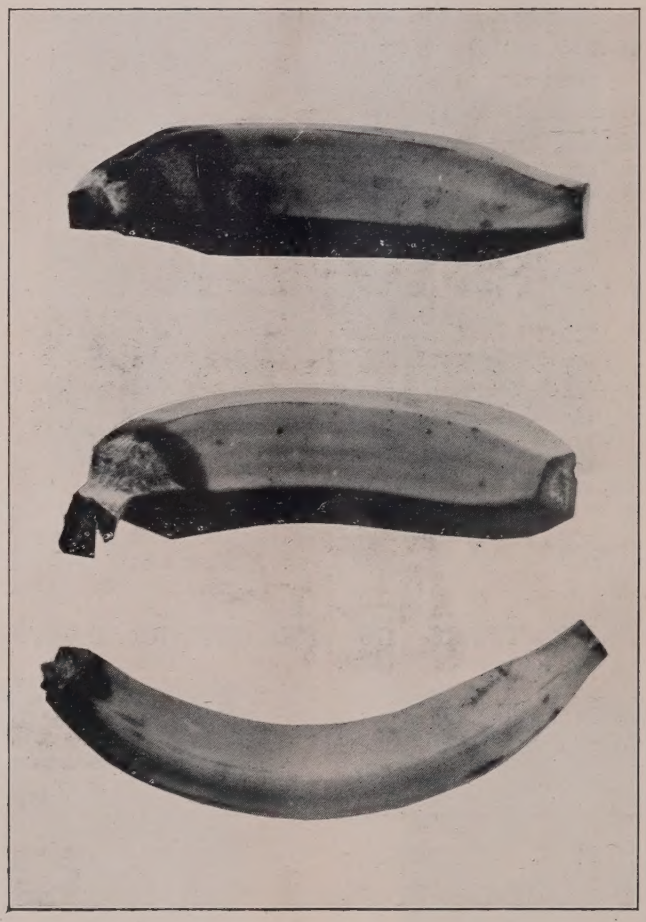


FIG. 1.—*Fusarium Tip-Rot.*

in order to collect bananas for the Imperial College of Tropical Agriculture collection. Mr. Sampson subsequently sent to Trinidad not only plants of the commercial type, but also plants of two sports of which it appears from descriptions and photographs that one is tall and one medium in height, whilst both resemble the ordinary dwarf in characters other than stature. These were obtained through the courtesy of Messrs. Yeoward Bros. from their plantations at Orotava. They have not yet fruited in the observation plots, and no further details can be given at present.

Turning now to the West Indian region, we find corresponding items of evidence which both confirm and supplement those drawn from the Canary Islands.

In 1927 Dr. S. C. Harland collected in Guadeloupe and handed over to the Imperial College of Tropical Agriculture collection a banana which was called "Giant Chinese". In general appearance and in fruit characters as studied in the field, this closely resembles the ordinary West Indian "Governor", but is readily distinguished by its taller growth.

In December, 1931, Monsieur D. Kervegant, Chef du Service de l'Agriculture in Martinique, published an article on the banana in Martinique (2), in the course of which he described two forms of the "Chinese" banana, distinguished as "Grande naine" and "Petite naine". The former is apparently our "Giant Chinese" and the latter the ordinary "Governor" of the British islands. But an extremely interesting feature of M. Kervegant's paper is a photograph showing stems of both types apparently growing from the same stool, as though the "Grande naine" is in the act of arising as a bud sport of the "Petite naine". Such is probably the fact, though in the absence of evidence of subterranean organic connection the photograph cannot be taken as conclusive.

Subsequently in correspondence M. Kervegant informed the present writer that he believes there exist within the two groups ("Grande naine" and "Petite naine") several sub-types, as with respect to the sterile flowers, for example, these are in some cases persistent up to maturity, whereas in other cases the rachis is entirely denuded. This last observation, as will appear, is of great importance.

In April, 1932, there appeared an article from the pen of Dr. C. J. J. van Hall (3) on the origin of a banana variety called "Congo," in which it is stated that this variety was named "Congo" in Surinam in order to hide its identity for commercial reasons, as it was immune to Panama Disease and gave some promise of becoming a useful substitute for Gros Michel. Prior to its re-naming it was called "naine géante" and was obtained from Guadeloupe. Having read Kervegant's paper, Dr. van Hall naturally assumes the identity of the "naine géante" of Guadeloupe with the "grande naine" of Martinique, and as he says, a name which formerly seemed unintelligible comes to appear particularly fortunately chosen.

"Congo," however, is in the Imperial College of Tropical Agriculture collection, and like "Bolinaga No. 4" is a variety with a consistently naked rachis. Hence, whilst we may accept it on Dr. van Hall's evidence as most probably a sport of the dwarf banana, emphasis is laid on M. Kervegant's belief that several such sports exist.

Finally there is an item to be added from Trinidad which helps to bridge the gap between types with persistent bracts, which may be accepted as mutants with considerable confidence and those types with a naked rachis for the origin of which the evidence is less direct. In October, 1931, Mr. H. Fahey and Mr. R. O. Williams drew the writer's attention to a banana variety in cultivation near San Juan which did not exactly correspond in characters with any variety in the Imperial College of Tropical Agriculture collection, though similar in many respects to both "Bolinaga No. 4" and "Congo." Plants were taken for comparison against those two standards, and the comparison is not yet complete, but the San Juan plant appears to be distinct. There can be no doubt that it belongs to the same group, and its most interesting feature is the variability which it shows in the field with respect to the bract character. Stools can be found with all the bracts persistent as in the dwarf type, and others with the rachis clean, whilst all intermediate conditions occur, and it is possible to find both extremes on different bunches in one and the same stool.

Such variability appears to remove the last obstacle in the way of regarding varieties like Congo, with a naked rachis, as derived from *M. Cavendishii*, and is becomes necessary to recognize provisionally a whole group of closely related varieties as so derived. Comparison between the individuals within the group is proceeding.

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(3) Van Hall, C. J. J.—De oorsprong van de "Congo-banaan." *De Indische Mercuur*, Vol. 55, No. 17, p. 245, 27 April, 1932.

SNAKE *v.* MONGOOSE.

Recently a full-grown specimen (6 ft. in length) of the Tree Boa (*Corallus Cookei*) was brought to the Imperial College of Tropical Agriculture. The stomach was enormously distended in proportion to the size of the snake. On dissection a full-grown mongoose was found. This is the second record of snakes capturing mongoose in Trinidad, the first one was that of a Boa Constrictor "Macajuel". Could agriculturists be persuaded not to slaughter these useful allies?

F. W. U.

BANANA DISEASES.

V.—Fusarium Tip-rot of Immature Cavendish Fruits.

By C. W. Wardlaw.

The comparative infrequency of plantation diseases of banana fruits in Trinidad has already been noted in these studies. In addition to Cigar-End (*Stachylidium theobromae* Turc.) and Black-Tip (*Helminthosporium torulosum* (Syd.) comb. nov. Ashby), a tip-rot of immature Cavendish fruits has occasionally been found in different parts of the Island. A similar rotting has also been noted on a plant labelled Grenada Giant in the College variety plot.

The disease has usually been observed on very young fruits, *i.e.*, while they are still small and angular and without starchy pulp. The rotting begins at the base of the degenerating perianth and progresses along the finger causing blackening and wrinkling of the skin and premature yellowing of the whole fruit. In well developed specimens the tip infection may extend over 2.5-3.5 cm. At this stage hyphae and spore-beds of a *Fusarium* may be present on the decayed tissue. Several stages of infection are illustrated. As a rule only two or three fingers in the entire bunch are affected. The disease is thus not of economic importance though occasional hands may be rendered unsightly.

On dissection, the internal tissues are found to be blackened, rotted and water-soaked. In the later stages, the decay is accentuated by various animal agencies, but these are merely common scavengers of secondary importance.

On mycological investigation two species of *Fusarium*, *F. moniliforme* Sh. var. *subglutinans* Wr. & Reink., and *F. lateritium* Nees.,* were isolated usually accompanied by bacteria. Other fungi were rarely isolated, a species of *Phomopsis* on one occasion and *Gloeosporium musarum* Cke. & Massee on another being the only records.

Hansford (1) has reported a finger-tip rot of the fruits of several banana varieties in Uganda, caused by *Fusarium moniliforme* Sh. The variety *subglutinans* has been described by Reinking and Wollenweber (2) from Central America on decaying leaves and pseudo-stems, in the vascular strands and on the exterior of living psuedo-stems, of the Gros Michel banana. Various other species of *Fusarium* have also been found associated with perianth remains, fallen fruit, and fruit in storage.

Inoculation experiments were carried out during the wet season with the two species of *Fusarium* and with *Gloeosporium musarum*. In each case the fungus was applied to the distal ends of wounded and uninjured immature fingers of the Cavendish variety; the wounds were made (i) by piercing the corky layer at the base of the perianth remains with a scalpel and (ii) by breaking off the remains of the style and perianth. The inoculated fruits were inspected at intervals till the bunches were ready for reaping, but negative results were obtained throughout. This finding, in conjunction with the occasional occurrence of the disease, suggests that some predisposing external or internal factor must be operative before penetration can be effected by the associated fungal organisms.

* Mr. S. F. Ashby of the Imperial Mycological Institute has kindly supplied these identifications.

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(2) Reinking, O. A., and Wollenweber, H. W.; "Tropical Fusaria". *Philippine Jour. Sci.*, Vol. 32, No. 2, 1927.

COTTON NOTES.

The Inheritance of Lint Colours in Upland Cotton.

By J. O. Ware, *Jour. Amer. Soc. Agron.*, Vol. XXIV, No. 7, July, 1932.

This paper contains an account of the mode of inheritance of lint colour in Upland cotton. The author points out that four shades of lint colour are present in Upland cotton. These are (1) dingy brown borne by the Algerian Brown Lint variety, (2) bright green borne by the Argentine variety, (3) yellowish-brown borne by the Nankeen variety, and (4) rust colour brown borne by the Texas Brown variety. All four types were crossed with ordinary white and the progenies studied. In each case the lint colour of the F_1 generation was intermediate between that of the coloured and white parent. In F_2 segregation occurred into an ordinary 1 : 2 : 1 ratio and the results of subsequent generations confirmed the hypothesis that each of the four lint colours is a clear cut mono-hybrid character. In certain cases the results were confirmed by back crosses to the recessives.

A correlation was found in the case of the green variety between colour and fineness. The green lint variety possessed a fine and silky texture and in F_2 the fine texture seemed to be completely linked with the green colour. In a review of the work of the Genetics Department of the Cotton Research Station, 1929*, the present writer called attention to the existence of two factor pairs for lint colour :

$G^1 - g^1$ ..Green lint—white lint
$K^1 - k^1$ ..Khaki lint—white lint

Experimental evidence was not presented in this review but the existence of the correlation between green lint and fineness was alluded to.

"An interesting case of correlation was observed between G^1 (green lint) and lint fineness. The green segregates are invariably finer than the white. Whether this is physiological or genetic correlation is not yet known."

Lint colour in cotton may be white, dirty-grey, various shades of brown or a green which rapidly fades to a rusty brown colour. A dirty-grey occurs in some cottons of the Nanking type from Burma. Brown cottons of various shades also

* *Empire Cott. Grow. Rev.*, 1929.

exist in the Old World group, and in New World cottons, browns are represented in the three main groups of cultivated cottons, Upland, Bourbon, and Peruvian. The two wild species from Polynesia, *G. tomentosum* Nutt and *G. taitense* Parl. also have brown lint. The most intensely pigmented type in our collection occurs in a Peruvian variety received from Ecuador under the name Pardo. No brown linted varieties of commercial Sea Island are known though there is considerable variation in the shade of cream. In Egyptian there is a very dark brown type (Enan's Brown) and the rest of the Egyptians vary between the rather strong pigmentation in commercial Uppers to the paler types such as Pima and Sakel. Green of various shades is strongly developed in the variety Texas Green Lint, an Upland type evidently closely resembling the Argentine variety described by Ware.

In reviewing previous work on the inheritance of lint colour the author points out the lack of agreement in the results of the lint colour investigations of other workers. In crosses between Upland and Egyptian, Balls stated that brown was not completely dominant over white but gave an intermediate F_1. In the F_2 generation a 1 : 2 : 1 ratio was obtained and plants with brown or white lint bred true up to the fifth generation. The intermediates continued to segregate as in the F_2 generation. Balls stated that among the extracted brown linted plants, some individuals were much darker in colour than the original Egyptian.

In the cross of Upland with white lint x Pima Egyptian with pale buff lint studied by Kearney the F_1 was intermediate in colour and the frequency curve of F_2 was uni-modal and symmetrical, although flatter than the curves for most of the characters studied. It appears however to the writer that Kearney was not working with an Egyptian form possessing the factor for brown lint but was really studying a cross between white and a dark cream containing plus modifiers for brown. The first paper on the inheritance of lint colour in Upland cotton known to the writer in which it is demonstrated that brown and white are allelomorphic is that of Thadani. In a cross between Texas Rust and a white variety the ratio of 41 coloured to 14 white was obtained in F_2.

The mode of origin of brown lint from the original wild prototypes may have an important bearing on the mode of inheritance of lint colour. Certain native races in Africa and also in South America prefer both brown and white cottons, as these can be used for making patterned fabrics. There would thus be a tendency to eliminate the intermediate grades of brown from the plant populations. Races which preferred white lint would presumably obtain this by selection against brown modifiers, unless as in Upland, white is not affected by modifiers.

The simplicity of inheritance of the main factor pair in inter-Peruvian crosses has not been found to apply in crosses of Sea Island White x Egyptian Brown studied at this Station. The F_1 is intermediate and the F_2 shows a series of at least ten different shades of brown with no clear line of demarcation between the classes. In further attempts to clear up this complex problem it was found that the cross of dark brown Egyptian x very light brown Pima gave simpler results than that of the Sea Island cross. It appeared indeed that the situation was analogous to that found in the inheritance of petal spot, namely that the factor pair was not the presence and absence of the character, *i.e.*, brown and white, but dark brown and light brown. The brown Egyptian apparently contains a series of plus modifiers acting on a basal factor B_r, while the recessive, which although white in the absence of the plus modifiers becomes intensified in their presence to a pale brown. Crosses between the heterozygote and homozygous brown give more clear cut results than F_1 x white, presumably because the allelomorphic pair of characters dark brown and light brown are better shown up in the presence of the plus modifiers.

Experiments to determine whether the gene for brown lint in Upland and Egyptian is identical have led to the conclusion that they are not, since crosses of Egyptian Brown x Upland brown backcrossed with white have given whites in about one quarter of the population. This cross obviously involves duplicate genes for brown lint and this case constitutes the third case of duplicate genes in New World cottons in which one member characterizes the Peruvian group and the other member the Upland group. Of the two chlorophyll deficient genes, C_{ha} and C_{hb}, C_{ha} is characteristic of Peruvian and C_{hb} of Upland, though many Uplands also contain C_{ha}. One of the duplicate genes for red, R_1, is confined to the Upland group and the other R_2, to the Peruvian and Bourbon groups.

Ware has established the existence of three different types of brown lint each of which is allelomorphic to white. It appears that the factor pairs in Upland are brown and white and not brown and less brown, *i.e.*, modifying factors apparently do not affect the expression of the recessive gene. It would be interesting to determine next the relationship between the various types of brown in Upland in order to determine whether duplicate genes are involved.

S. C. H.

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A LIST OF THE FROGS AND TOADS OF TRINIDAD.

By H. W. Parker.

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During recent years a number of so-called "check lists" of the amphibians of various geographical regions have appeared, and little or no apology would be needed for the publication of a similar list for Trinidad; references to the frogs of Trinidad are scattered through a mass of scientific literature and the most recent attempt to enumerate them (1) is far from complete. But such a list is of little value to the field worker and to the non-specialist, for, to be able to apply the names contained in it correctly, necessitates either an extensive knowledge of the animals, or access to literature or to named collections. It cannot be too strongly emphasised that the precise identification of animals, especially where the fauna is particularly rich or incompletely known, is a matter for the experienced specialist; too many zoo-geographical "problems" arise through mis-identifications. But where the fauna is limited and free from perplexing, intergrading sub-species it should be possible to produce a "Key" by means of which any person of normal intelligence, who is willing to take some pains, can identify the material he is likely to encounter. A "Key", which it is hoped will fulfil these conditions, is accordingly offered with this list.

The list itself is annotated, more for the benefit of the systematist than for anyone else, and under each name a series of references is given. The first reference is always that from which the specific or subspecific name dates; then follow the first record from Trinidad (if different from the first citation), and other Trinidad references which may have appeared under different names and, finally, an indication of where a good, modern figure or photograph can be found. In a few instances no figure has been published and to check the identification of specimens of these species it will be necessary to compare them with technical descriptions. All species known prior to 1882 are fully described in the Catalogue of Batrachia Salientia in the British Museum, Ed. 2, whilst for species described since that date it is usually necessary to consult the original description.

Twenty-three species are here recorded from the island, four for the first time. Of these four, one may possibly be based on a specimen with incorrect locality data, but the other three are species which do not appear to be exceptionally rare and one (*Hyla rubra*), is certainly common. It is scarcely conceivable that such a common species has been consistently overlooked by the many zoological collectors who have worked on the island, and the only alternative explanation is that it is a recent introduction which has established itself and is now multiplying fast. It is quite possible that *Hyla punctata* and *Bufo granulosus* are, similarly, recent arrivals, and the importation of agricultural produce from the mainland and elsewhere may well be expected to result in further additions to the amphibian fauna. Some species, however, have been recorded but do not seem to have been found again in recent years, despite the diligent collecting of Mr. F. W. Urich, whose interest has inspired the present paper and on whose collections most of the new records are based. How far these old single records can be relied upon is uncertain; but the depredations of the mongoose, which are known to have exterminated numerous members of the native fauna of the Antilles, may reasonably be expected to have had a similar effect in Trinidad.

A. KEY FOR THE IDENTIFICATION OF THE SPECIES.

This key, being intended to facilitate identification, is concerned more with differences than with resemblances and consequently does not, except occasionally by chance, give any clue to the relationships of the various species considered.

(1) (*a*) No tongue; fingers ending in star-shaped sensory discs **Pipa pipa** (Linn.)
(*b*) Tongue present; digital discs, if present, circular, not star-shaped .. (2)

(2) (*a*) No teeth; no digital discs .. (3)
(*b*) Teeth present at least in the upper jaw; digital discs present or absent .. (6)

(3) (*a*) Skin quite smooth; snout long, prominent, pointed; eye very small; a yellow or white line along the hinder side of the thighs **Elachistocleis ovale** (Schneid.)
(*b*) Skin warty; snout short, rounded; eye normal .. .. (4)

(4) (*a*) No bony ridges on the head; warts forming a diamond-shaped figure between the shoulders; adult size about 28-32 mm. from snout to vent
Eupemphix pustulosus trinitatis Boulenger.

(*b*) Head with projecting bony ridges, especially above the orbits; no diamond-shaped figure on the back; adults more than 50 mm. from snout to vent .. (5)

(5) (*a*) Skin with uniform, closely set warts; snout projecting well beyond the mouth; no fold along the inner edge of the tarsus
Bufo granulosus Spix.

(*b*) Skin with irregularly scattered warts; snout scarcely projecting; a dermal fold along the inner edge of the tarsus
Bufo marinus (Linn.)

(1) Lutz, *Mem. Inst.*, Oswaldo Cruz, XXX, 1927, pp. 35-65 records only 14 spp.

(6) (*a*) Discs present on the tips of the fingers and toes .. .. (7)

(*b*) No digital discs .. .. .. (19)

(7) (*a*) Each disc with a pair of scale-like scutes on its upper surface; a narrow dark line across the throat **Phyllobates trinitatis** Garman.

(*b*) Upper surfaces of digital discs plain, smooth; no dark line across the throat (8)

(8) (*a*) A row of tooth-like serrations on the lower jaw. Back black with two yellow or white stripes, each widening anteriorly to enclose a black spot behind and above each eye, and joining its fellow across the top of the snout **Amphodus auratus** Boul.

(*b*) No tooth-like serrations on the lower jaw .. .. (9)

(9) (*a*) Pupil a vertical ellipse; inner (first) toe longer than the second. Bright green above; flanks and sides of hind limbs with large yellow or orange spots; purplish-brown beneath, with round cream-coloured spots on the throat and beneath the limbs **Phyllomedusa burmeisteri** Boul.

(*b*) Pupil round or horizontal; inner (first) toe shorter than the second .. (10)

(10) (*a*) Toes not webbed; tip of outer (fifth) toe extending well beyond the tip of the third. Groin and fore and hinder sides of the thighs carmine **Eleutherodactylus urichi** (Boettger).

(*b*) Toes distinctly webbed; outer (fifth) toe and third approximately equal .. (11)

(11) (*a*) Outer two fingers webbed almost to the discs; a triangular lappet of skin on the heel; lower eyelid with metallic venation .. .. (12)

(*b*) Outer two fingers not more than half webbed; no lappet on the heel; lower eyelid without veins .. .. (13)

(12) (*a*) Disc of the fourth toe involved in the webbing **Hyla maxima** (Laur.)

(*b*) Web not reaching the disc of the fourth toe. Flanks and concealed surfaces of the thighs with vertical black lines or ring-like spots in adults, completely black in juveniles **Hyla punctatissima appendiculata** Boul.

(13) (*a*) Fingers without any web; groin and concealed surfaces of thighs and tibiae brown, with yellow spots **Hyla rubra** Daud.

(*b*) Fingers with at least some web; groin and thighs not yellow-spotted .. (14)

(14) (*a*) Skin of upper surfaces rough and glandular, often warty; male with a black vocal sac projecting above each arm **Hyla venulosa** (Laur.)

(*b*) Skin of upper surfaces smooth; vocal sac of male single, beneath the chin .. (15)

(15) (*a*) Flanks with vertical black bars; size moderately large (50-70 mm.); male with a spur-like process at the base of the inner finger **Hyla crepitans** Wied.

(*b*) Flanks not barred; small species (less than 40 mm.) .. .. (16)

(16) (*a*) A narrow reddish line along the edge of the snout (canthus rostralis) and from the hinder corner of the eye to the groin; upper surfaces regularly stippled with minute brown or reddish dots, sometimes with a few larger pink spots; male with a spur at the base of the inner finger **Hyla punctata** (Schneid.)

(*b*) No pink lines or dots on the back; no spur on the thumb of the male .. (17)

(17) (*a*) A short white line above the vent and one on each heel; no dark markings on the sides of the head or flanks; snout shorter than the eye **Hyla minuta** Peters.

(*b*) No light line above the vent or on the heels; flanks or back with dark stripes; snout longer than the eye .. (18)

(18) (*a*) Sides of head, temples and flanks dark, sharply marked off from the upper surfaces which are very variable in colour; thighs uniformly coloured **Hyla goughi** E. G. Boul.

(*b*) Two dark lines on each side, one from behind the eye and one behind the ear; fore and hinder sides of the thighs brown-marbled **Hyla lineomaculata** Werner.

(19) (*a*) Toes webbed to the tips .. (20)

(*b*) Toes without any web, or with only a lateral fringe .. .. (21)

(20) (*a*) Skin of back shagreened; a strong ridge running backwards from the eye and separating the back from the flanks **Rana palmipes** Spix.

(*b*) Skin of back smooth; no dorsal-lateral ridge **Pseudis paradoxa** (Linn.)

(21) (*a*) Toes not fringed laterally; groin and hinder side of thighs black, spotted or marbled with bright red **Leptodactylus pentadactylus** (Laur.)

(*b*) Toes with fringes of skin laterally; no red on thighs or groin .. .. (22)

(22) (*a*) Back with 6 well-marked longitudinal ridges **Leptodactylus typhonius** (Daud.)

(*b*) Skin of back perfectly smooth **Leptodactylus petersi** (Steindach.)

B. ANNOTATED LIST AND REFERENCES.

PIPIDAE.

(1) Pipa pipa (Linn.) SURINAM TOAD.

Rana pipa Linn., 1758, *Syst. Nat.*, ed. 10, p. 210.
"The *pipa* or Surinam toad" Anon., 1924, *Handbook of Trinidad and Tobago*, p. 100.
Pipa pipa, Mir. Ribeiro, 1926, *Arch. Mus. Mac.*, Rio de Janeiro, XXVII, Pl. xxii (colour).

HYLIDAE.

(2) Pseudis paradoxa (Linn.) PARADOXICAL FROG.

Rana paradoxa Linn., 1758, *Syst. Nat.*, ed. 10, p. 212.
"Paradox Frog" Anon, 1924, *Handbook of Trinidad and Tobago*, p. 100.
Pseudis paradoxa, Mir. Ribeiro, 1926, *Arch. Mus. Mac.*, Rio de Janeiro, XXVII, Pls. i and ii, figs. 1 and 1a (colour).

This aquatic frog is said, in the *Handbook* quoted above, to be rare in Trinidad; no specimens have been examined, and it is not impossible that there may have been some confusion of this species with *Rana palmipes*, which is well known in the Island and which resembles *Pseudis* in its habits.

(3) Amphodus auratus Boulenger.

Amphodus auratus (Wied.) Boulenger, 1917, *Ann. Mag. Nat. Hist.* (8), XX, pp. 184-185.

This rare, bromeliad-dwelling frog has only hitherto been recorded once in the literature of Trinidad and has not been figured. Boulenger, when describing it, thought that it might be the species recorded by Wied from Brazil under the name *Hyla aurata*, but comparison of the six specimens in the British Museum (all from bromeliads on Mt. Tucuché at about 3,000 ft.) with Wied's figure shows a difference in colour pattern which is constant. *Hyla aurata* has 3 definite, yellow, longitudinal stripes, but *Amphodus auratus* has only two, much broader and widening in a characteristic manner on the head to enclose a dark spot. Consequently the identity of the two must be considered as very doubtful and the Trinidad species can be known as *Amphodus auratus* Boul.

(4) Phyllomedusa burmeisteri Boulenger.

Phyllomedusa burmeisteri Boul., 1882, *Cat. Batr. Sal. Brit. Mus.*, ed. 2, p. 428. Mole and Urich, 1894, *Journ. Trinidad Field Nat. Club*, p. 90.
P. trinitatis Mertens, 1926, *Senckenbergiana*, VIII, p. 145.
P. burmeisteri, Mir. Ribeiro, 1926, *Arch. Mus. Nac.*, Rio de Janeiro, XXVII, Pl. v, figs. 6-6a (colour).

(5) Hyla maxima (Laurenti).

Rana maxima Laur., 1768, *Syn. Rept.*, p. 32.
Hyla maxima Werner, 1899, *Verh. Zool.-Bot Ges.*, Wien, XLIX, p. 483. Mir. Ribeiro, 1926, *Arch. Mus. Nac.*, Rio de Janeiro, XXVII, Pl. ix, fig. 1 (colour).

(6) Hyla punctatissima appendiculata Boulenger.

Hyla appendiculata Boul., 1882, *Cat. Batr. Sal. Brit. Mus.*, ed. 2, p. 349. Werner, 1899, *Verh. Zool.-Bot. Ges.* Wien, XLIX, p. 483.
Hyla spectrum Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, pp. 64, 65.
Hyla appendiculata Boulenger, 1882, *tom. cit.*, Pl. xxiii, fig. 2.

This frog, with its different ontogenetic colour phases, has been the cause of much nomenclatorial confusion. Lutz, in recording it from Trinidad under the name of *H. spectrum*, has pointed out that the tadpoles and metamorphosing young are completely black. By the time metamorphosis is complete the relative amount of black pigment has been greatly reduced and the animal is now pink or cream-coloured above, with numerous small black dots, and immaculate white beneath; those surfaces of the limbs and flanks which are concealed when the frog is at rest alone remain black. Lutz unaccountably makes the strange assumption that these froglets are almost full-grown, but specimens in the British Museum show that this colour is only transitional and is intermediate between the black livery of the larvae and the adult colour-pattern. In mature examples the black pigment becomes still further reduced, the dorsal spots becoming almost, or quite, indistinct and the black on the limbs and flanks becoming reduced to a series of vertical bars; at the same time the adult pattern, consisting essentially of a large X on the anterior part of the back, a transverse lumbar bar, a spot on the snout and bars on the exposed surfaces of the legs gradually makes its appearance.

These different colour phases have, at one time or another, been described as distinct species; there is little doubt that the dark-limbed juvenile phase has been described three times, viz.:—

(*a*) *Hylella punctatissima* Reinhardt and Lütken, 1862, *Vid. Meddel.*, 1861, 13, p. 200, Pl. iv, fig. 5. (Type-locality Minas Geraes.)
(*b*) *Centrotelma cryptomelan* Cope 1867, *Journ. Acad. Philad.* (2), VI, p. 204. (Type-locality Bahia.)
(*c*) *Cophomantis punctillata* Peters, 1870, *Mon. Ak.*, Berlin, p. 651, Pl. ii, fig. 4. (Type-locality Sta. Catherina.)

The adult only appears to have received one name:—

Hyla appendiculata Boulenger, 1882, *Cat. Batr. Sal. Brit. Mus.*, ed. 2, p. 349, Pl. xxiii, fig. 2.

Boulenger's cotypes were collected in several different localities, but the specimen figured is number 80.12.5.168 in the British Museum from Canelos, Ecuador, and may be taken as the lectotype of the name.

Lutz, as has been mentioned, refers juvenile specimens from Trinidad to *H. spectrum* Reinhardt and Lütken, but this form is said to have an almost vertical loreal region, a dark canthal stripe and a pattern of cross-bars on the back, characters not found in the large series of *H. punctatissima* examined.

The species is a wide-ranging form and specimens from Trinidad, E. Ecuador, E. Peru, Bolivia, Mattoo Grosso, Sta. Catherina, Sao Paulo, Rio and Bahia

have been examined. This series shows some variation, particularly in the degree of webbing of the fingers and toes. In the north, *i.e.* Trinidad, Ecuador and Peru the fingers are at least 2/3 webbed, the membrane almost reaching the discs of second and fourth, and its free edge being noticeably convex between the two outer; the toes are webbed to the discs of all except the fourth. Bolivian and Brazilian specimens, on the other hand, have the fingers only about 1/2 webbed, the membrane not reaching nearly to the discs of any digits and its free edge being straight or concave between the outer ones; the toes, too, are distinctly less webbed than in northern examples, the inner having the penultimate phalanx almost free. No hard and fast line can be drawn between these two forms for an example from Pacaya, Peru, is almost exactly intermediate, and Bahia specimens, also, have rather more web than those from Matto Grosso and Bolivia. Consequently it seems probable that we have to do with a variable species which has two or more recognisable local races. At present it is only suggested that these should be recognised for which names are already available, that is :—

(i) *Hyla punctatissima punctatissima* (Reinhardt and Lütken), from Brazil and Bolivia.

(ii) *Hyla punctatissima appendiculata* Boulenger, from Eastern Peru, Eastern Ecuador and Trinidad.

The distribution of this latter subspecies is not so extraordinary as appears at first sight, for several frogs are known to have a somewhat similar distribution. Thus, for example, *Phyllomedusa perlata* Boulenger and *Lithodytes lineatus* (Schneid.) are both known from the Amazon drainage of Peru and Ecuador and from the Guianas, without a single record of either from the intervening territory.

(7) **Hyla rubra** Daudin.

Hyla rubra Daudin, 1803, *Hist. Rainettes*, p. 26. Mir. Ribeiro, 1926, *Arch. Mus. Nac.*, Rio de Janeiro, XXVII, Pl. vii, figs. 4-4a (colour).

Strangely enough this tree-frog, so common on the South American mainland, does not appear to have been previously recorded from Trinidad, unless indeed *Hyla lineomaculata* Werner is really based on specimens of *H. rubra*. The British Museum possesses 7 specimens from various localities on the island, all collected within the last few years.

(8) **Hyla venulosa** (Laur.)

Rana venulosa Laurenti, 1768, *Syn. Rept.*, p. 31.

? *Hyla pardalis* (non Spix) Garman, 1887, *Bull. Essex Inst.*, XIX, p. 16.

? *Hyla coriacea* (non Peters) Mole and Urich, 1894, *Journ. Trinidad Field Nat. Club*, p. 90.

Hyla venulosa Roux, 1926, *Rev. Suisse Zool.*, XXXIII, p. 297. Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, XX, Pl. xiv.

This species was not recorded from Trinidad under its present name until 1926, but there is good reason for believing that the specimens recorded by Garman and Mole and Urich under the above-mentioned names were wrongly identified.

(9) **Hyla crepitans** Wied.

Hyla crepitans Wied, 1824, *Abbildungen Nat. Bras.*, Pl. xlvii, fig. 1. Boettger, 1892, *Kat. Batr. Senckenberg*, p. 40. Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, XX, Pl. xv, figs. 35-36.

(10) **Hyla punctata** (Schneid.)

Calamita punctatus Schneider, 1799, *Hist. Amph.*, I, p. 170.

Another species not previously recorded from Trinidad but represented in the British Museum by specimens from Maracas Bay, Las Cuevas and St. Augustine.

(11) **Hyla goughi** E. G. Boulenger.

Hyla goughi E. G. Boulenger, 1911, *Proc. Zool. Soc.*, London, p. 1082.

Hyla misera (non Werner) Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, XX, pp. 43, 50, 59, 64.

Hyla goughi E. G. Boulenger, 1911, *tom. cit.*, Pl. lxiv (colour).

Unfortunately only two of the original series described by E. G. Boulenger appear to have been preserved, and these are now in the British Museum. Examination of them shows, however, that they are not conspecific, one being apparently *H. minuta* Peters (q.v.). There can be no doubt that the name *goughi* must be attached to the species represented by the other specimen, for this has the fingers and toes less webbed than *H. minuta* and so accords with the original description. Lutz (*loc. cit.*) regards *goughi* as a synonym of the Venezuelan *misera* Werner, and this disposition may ultimately prove to be correct. But, as Werner described the fingers and toes of *misera* as half and fully webbed respectively, whereas those of *goughi* are 1/4 to 1/3 and 4/5 webbed, it seems more prudent to retain both names until the apparent discrepancy has been accounted for.

(12) **Hyla minuta** Peters.

Hyla minuta Peters, 1872, *Mon. Ak.*, Berlin, p. 680.

This species must now be admitted to the fauna of Trinidad on the basis of the specimen mentioned in the preceding paragraph. But it is possible that an accidental transference of specimens may have occurred at some time and that the specimen included with *H. goughi* may not have originated in Trinidad at all.

(13) **Hyla lineomaculata** Werner.

Hyla lineomaculata Werner, 1899, *Verh. Zool. Bot. Ges.*, Wien, p. 483.

The status of this species, known only from original specimens collected at Arima in 1897, is very doubtful. Beebe (*Zoologica*, II, 1919, p. 208) has recorded it from British Guiana, but Barbour (*Amer. Nat.*, LIV, 1920, p. 287) commenting on this record suggests that the species may not be distinct from *H. rubra*.

BUFONIDAE.

(14) **Bufo marinus** (Linn.)

Rana marina Linn., 1758, *Syst. Nat.*, ed. 10, p. 211.

Bufo marinus Boulenger, 1882, *Cat. Batr. Sal. Brit. Mus.*, ed. 2, p. 315.

Bufo marinis Garman, 1887, *Bull. Essex Inst.*, XIX, p. 15.

"Marine Toad" Ditmars, 1905, *Bull. New York Zool. Soc.*, 18, p. 233, fig.

(15) **Bufo granulosus** Spix.

Bufo granulosus Spix, 1824, *Nov. Spec. Test. Ran. Bras.*, p. 51. Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, XX, Pl. viii, figs. 5-6.

Compared with the preceding species this toad must be accounted rare in Trinidad. It has not previously been recorded from the island but the British Museum has 4 examples; a young specimen was collected by Mr. Urich in a bromeliad in Mt. Tucuché.

CERATOPHRYIDAE.

(16) Eleutherodactylus urichi (Boettger).
Hylodes urichi Boettger in Mole and Urich, 1894, *Journ. Trinidad Field Nat. Club*, p. 88.

(17) Leptodactylus pentadactylus (Laur.)
Rana pentadactyla Laurenti, 1768, *Syn. Rept.*, p. 32.
Leptodactylus pentadactylus Mole and Urich, 1894, *Journ. Trinidad Field Nat. Club*, p. 89. Lutz, 1926, *Mem. Inst.*, Oswaldo Cruz, XIX, Pl. xxx, figs. 1 and 2 (colour).

This species, widely distributed and much esteemed on the mainland, has only once been reported in Trinidad; its present status there is consequently uncertain and it may well have been exterminated by the mongoose.

(18) Leptodactylus typhonius (Daud.)
Rana typhonia Daudin, 1803, *Hist. Rainettes*, p. 55.
Leptodactylus longirostris (non Boulenger) Garman, 1887, *Bull. Essex Inst.*, XIX, p. 14. Mole and Urich, 1894, *Journ. Trinidad Field Nat. Club*, p. 89.
Leptodactylus typhormis (misprint) Hart, 1891, *Ann. Rep.*, R. Bot. Gardens, Trinidad, 1890, p. 25.
Leptodactylus typhonius Lutz, 1926, *Mem. Inst.*, Oswaldo Cruz, XIX, Pl. xxxii, figs. 1 and 2 (colour).

(19) Leptodactylus petersi (Steindachner).
Platymantis petersi Steindachner, 1864, *Verh. Zool.-Bot. Ges.* Wien, XIV, p. 254.
Leptodactylus caliginosus Hart, 1891, *Ann. Rept.*, R. Bot. Gardens, Trinidad, 1890, p. 25.
Leptodactylus natalensis Lutz, 1930, *Mem. Inst.*, Oswaldo Cruz, XXIII, Pl. i, fig. 7 (colour).

This species has hitherto been known almost universally as *L. caliginosus*, but Lutz has given reasons for believing that a number of species were confused under that name. The Trinidad form appears to be the same as that from Venezuela, which should be known as *petersi*, but the northern Brazilian specimen which he figures under the name of *natalensis* also appears to belong to the same species.

(20) Eupemphix pustulosus trinitatis Boulenger.
Eupemphix trinitatis Boulenger, 1889, *Ann. Mag. Nat. Hist.* (6), III, p. 307.
Bufo atrigularis Werner, 1899, *Verh. Zool.-Bot. Ges.*, Wien, XLIX, p. 482.
Eupemphix pustulosa Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, XX, pp. 64, 65.
Eupemphix trinitatis Netting, 1930, *Ann. Carnegie Mus.*, XIX, 4, 1930, pp. 249-254.
Eupemphix pustulosa Lutz, 1927, *tom. cit.*, Pl. xii, figs. 25-26.

Two recent reviewers (Lutz and Netting) have disagreed as to the status of this form. Netting maintains that Trinidad harbours a distinct local form differing from that of the mainland in colour and size. The colour differences he cites seem very trivial and even on the very scanty material available to the author do not appear to be constant. Specimens from Panama in the British Museum are almost indistinguishable from other examples from Trinidad. The differences in size, stated to exist but not specified, are, also, not apparent. Pending a settlement of this problem the name *trinitatis* can be used although it is highly improbable that it should receive more than sub-specific status.

PHYLLOBATIDAE.

(21) Phyllobates trinitatis Garman.
Phyllobates trinitatis Garman, 1887, *Bull. Essex Inst.*, XIX, p. 13.
Prostherapis trinitatis Mole and Urich, 1894, *Journ, Trinidad Field Nat. Club*, p. 87.
Phyllobates trinitatis Boulenger, 1895, *Proc. Zool. Soc.*, London, Pl. X, figs. 4-5 (colour).

GASTROPHRYNIDAE.

(22) Elachistocleis ovale (Schneid.)
Rana ovalis Schneider, 1799, *Hist. Amph.*, p. 131.
Engystoma ovale, Mole and Urich, *Journ. Trinidad Field Nat. Club*, p. 88, Lutz, 1927, *Mem. Inst.* Oswaldo Cruz, Pl. viii, fig. 2.

RANIDAE.

(23) Rana palmipes Spix.
Rana palmipes Spix, 1824, *Nov. Spec. Test. Ran. Pras.*, p. 29. Roux, 1926, *Rev. Suisse Zool.*, XXXIII, 4, p. 297. Lutz, 1927, *Mem. Inst.*, Oswaldo Cruz, XX, Pl. ix.

THE TONCA BEAN TREE.*

This tree, botanically known as *Dipteryx odorata* or *Coumarana odorata* (*Leguminosae*), provides from its bean an essential oil containing coumarin, one of the bases used in the manufacture of perfumes. It is a native of Venezuela and the Guianas. The tree is cultivated on a small scale in Trinidad. The price fluctuates, that obtaining at the moment, 3s. to 4s. per lb., being considered sufficiently remunerative to warrant an extension of plantings. Though usually grown from seed, when the trees take from seven to fifteen years to come into bearing, it has been stated that the budding or grafting of selected scions on seedling stocks will reduce the period to 3 years, as well as increase yield. When there is no other cultivation, the number of trees per acre should be about 50, but, as the trees make admirable windbreaks for other produce, it is suggested that they would be most economically used by being so planted as to serve this purpose in addition to their crop production. The Tonca bean is not particular as to soil, has a long tap root and withstands drought well. In Trinidad it has been planted with success on ground formerly considered unfit for cultivation. If it has a preference, it is for a sandy loam. The average yield of a full grown tree is about 10 lb. of beans. The bean is prepared for the trade by maceration in strong rum in casks for a few days. The rum is then run off and the beans dried and packed for export, the United States forming the principal market.

* T. I. Potter. *Proc. Agr. Soc. Trinidad and Tobago*, 1932, 32, 167-71. *Horticultural Abstracts*. Vol. V, No. 3.

STUDIES IN TROPICAL LAND TENURE.

By H. Martin Leake, sc.d.

West Africa.

European contact with West Africa as it is now understood, with its sea approaches, dates from early in the fifteenth century though it must not be forgotten that an earlier contact existed through the desert routes from Mediterranean ports and that, in the hinterland, a highly organized community existed in Melistan which came under the influence of the Arabs and Berbers and the Moslem religion. That history is of concern here inasmuch as it explains the striking contrasts found in the customs of the coastal tribes and those of the hinterland in the various British Dependencies of the coast; a full account is to be found in Lady Lugard's fascinating book (1). Between these two contacts there is a sharp break and modern history is concerned with the coastal approach where contact was with the pagan tribes which inhabited the coastal tracts and through which contact was later established with the tribes of the interior. This early history of discovery and settlement of the coast is marked by the same rivalry between European nations that has been seen to have occurred in the East. The first nation to enter the field was the Portuguese; British contact was not established till early in the 17th century. The stimulus and the consequent rivalry lay in the valuable slave trade, but other products, such as gold, ivory and 'pepper' were obtained which have left their mark in the various names applied to parts of the coast, such as the Gold Coast, Ivory Coast and the less well known Grain Coast; the latter referring to 'pepper' or 'the Grain of Paradise' which is derived from a species of *Amomum* and is not the true pepper of the East. Two factors, however, militated against any large penetration from the coast; a relatively dense population rendered hostile through the slave trade and a forbidding climate. For long European influence was in the material sense limited to the possession of fortified posts situated along the coast and penetration into the interior commenced only when the abolition of slavery administered the death blow to the major source of lucrative trade and a new economic justification had to be found for the continued occupancy of the tract. Among those products in which a new source of profit was found, palm oil soon took the most important place.

Though, in 1588, a Patent was granted by Queen Elizabeth giving a ten years' monopoly on the Senegal and Gambia rivers to a body of merchants, the first effective British contact dates from 1618 when a trading company was formed which established forts on the Gambia and at Cormantine on the Gold Coast; in 1787 Sierra Leone was acquired by a Company under a Charter dated 1791 while Nigeria arose from the cession of Lagos in 1861. The details of this early period have little bearing on the present subject and are to be found in Sir Charles Lucas' history (2). It is a history of international rivalry resulting in a gradual sorting out of spheres of influence and, within the British sphere, a series of administrative adjustments which renders the sequence of development in each territory somewhat difficult to follow.

The existing four areas, the Gambia, Sierra Leone, the Gold Coast and Nigeria have this in common that they started as trading stations with control over land limited to the actual forts and an indefinite surrounding area generally limited to the range of the guns. In these areas, which have come to be defined as Colonies, it is the English ideas regarding land as personal property, which have prevailed and it is, further, an urban outlook. In the first place, the merchants desired a firm title to their land; in the second, they preferred fixed property as guarantees for the fidelity of their responsible employees. As a consequence the English law in its bearing on landed property was adopted in all its purity. Land became a personal asset and questions of title became the sport of the legal community, to be threshed out in the Courts. Added to this, penetration into the interior was gradual and the tendency was for the attitude towards land which had been adopted in these earlier settlements to be applied to the more recently acquired territories. Only in the later cases from about the commencement of the present century, when protectorial rights were declared over large areas of the hinterland, was any clear statement made on the various rights in land and even of the rights claimed by the paramount power. To this gradualness of penetration as well as to the lack of any clear comprehension of the issues involved, is due much of the confusion which characterizes the land tenure systems of West Africa.

The Gold Coast.

The early history of this territory prior to 1821 may be passed over. At that date, mainly as the result of the abolition of the lucrative slave trade, the African Company of Merchants was disbanded and the Gold Coast placed under the Crown. After a chequered history involving many administrative changes, the Anglo-Dutch Convention, signed in 1871, and delimiting the coastal spheres of influence, started the territory in life as a definite entity of the British Empire. While the Convention delimited the coastal boundaries, the limits in the interior were nebulous and only after the final defeat of the Ashantis in 1900 was the way open for complete control of the country to be taken. The Dependency was then divided into the Colony, consisting of the coastal belt and bounded by Ashanti on the North; Ashanti itself and the Northern

Territories over which a Protectorate had been declared in 1897. The Dependency was finally rounded off by the delimitation of the Anglo-French and Anglo-German boundaries in 1898 and 1899 respectively, the only subsequent change of area being the addition of the mandated territory of Togoland in 1919.

While there is a very definite similarity in the evolution of the land system in the Colony and Ashanti, that of the Northern Territories is markedly different. The Northern Territories lie beyond the rains belt and are physically separated from the rest of the Dependency by lack of transport facilities. The country is sparsely populated with no well established tribal authority, and, both agriculturally and geologically, offers little or no great attraction to the alien, whether settler or miner. The similarities between the Colony and Ashanti are largely climatological; lying as they do within the rains belt, land has come to possess an agricultural value, especially for cacao, the rise of which industry is too well known to be recapitulated here. They are partly geological; gold particularly has been responsible for, at times, an intense demand for concessions to prospect for, and mine minerals. The difference lay in the existence in Ashanti of one of the best established native organizations of West Africa with a highly developed feudal system whereas, in the Colony, no such powerful native organization existed. Further, as has been said, European contact had introduced a large element of English law into the attitude towards land.

Governmental interest in land arose from various causes. In the first place, there were its own requirements to be satisfied if it was to fulfil the normal functions of a Government; the need of land for roads, railways, public buildings and so on. Secondly, there was a definite need for control which would ensure that land did not pass into alien possession to the detriment of the native holder, the dangers of which had become apparent during the Gold Rush of the early Eighties. Thirdly, a point which arises in every well afforested country, there was the need for protection of the forests as a national asset, for these were being rapidly destroyed under the triple stimulus of shifting cultivation, felling to provide fuel for mining operations as well as for the export of timber and, later, clearance to make way for the growing cacao industry.

As early as 1876 provision was made under the Public Lands Ordinance (Ord. 8 of 1876) to meet the first requirement. Under this Ordinance absolute purchase from owners for a money consideration was rendered lawful in the case of land required for the service of the Colony and provision to the same end was made in the Ashanti Ordinances Nos. 1 and 2 of 1902 which laid down the methods of administration of this newly conquered territory. The two further desiderata were not so readily met. As has been explained, control over the Colony was gradually acquired and no general statement of the relationship between Government and the combined native authorities concerned was made. On the conquest of Ashanti, in like manner, no general statement was made and merely an area round the fort at Kumasi was declared to be Crown Land with similar declarations concerning the sites of district headquarters. In both cases the interest of Government in the land was nebulous. The need for some Governmental control, however, early became apparent and a movement to settle the question was made by the Secretary of State in 1890. In 1894 an Ordinance, similar to the Crown Lands Ordinances of other Dependencies, was introduced which aimed at vesting all waste lands, forest lands and minerals in the Crown. The measure obviously foreshadowed the alienation of lands so acquired by the Crown to non-natives for development under the then prevalent system of plantations and was strenuously opposed on the grounds that, under native custom, there were no such waste lands. The Ordinance was not carried into law and in 1895 an investigaton was made into native custom as it bore on the land. The report (3) draws no conclusions, and merely consists of a series of statements by numerous officials and by the Editor of the *Gold Coast Independent*. In 1897 a modified Ordinance was introduced with the object of defining the position of Government. It is unnecessary to follow here the various stages of the somewhat heated and protracted discussions which led to the withdrawal of this Ordinance and to the deputation of Mr. (later Sir) Conway Belfield of the Malay service (4). After the withdrawal of the 1897 Ordinance it became the accepted policy that there existed no Public Lands other than those acquired by purchase and that other means must be sought for exercising the control necessary for the protection of the native and for the preservation of the forest areas.

Of the two outstanding questions, that of the alienation of land by natives to concession seekers primarily with a view to mining and that of forest preservation, the former was at this time of the more pressing importance. It was met by the passage in 1900 of the Concessions Ordinance (Ord. 14 of 1900) which legalized the essence of a section of the abortive 1897 Ordinance. Though the main practical issue was one of mining, the Ordinance took within its purview agriculture and forestry in as far as the latter concerned timber. Under it a Concession is defined as a "writing whereby any interest or property on or over land and in or to minerals, precious stones, timber, rubber or other products of the soil or growing on any land . . . purports to be either directly or indirectly granted . . . by a native". Section 21 of the Ordinance lays down that (1) no concession is valid which, in the case of mining, concerns more than five square miles or, in the case of timber, collecting rubber or relating to other products of the soil, twenty square miles and (2) concessions in the aggregate to single persons must not exceed, in the case of mining,

twenty square miles and, in other cases, forty square miles. The Ordinance also imposed a duty on profits. Its application was only to the Colony but later an Ashanti Ordinance was passed (Ord. 2 of 1904) of the same tenor to extend the control to Ashanti.

The history of the forest problem was similar only more prolonged; a history which included the abortive Forest Ordinance of 1911 and a quiet dropping of the thorny question till after the War. Discussions between 1923 and 1927 resulted in the passage of the Forest Ordinance (Ord. 13 of 1927) applicable both to the Colony and Ashanti. This Ordinance rendered it lawful to institute Forest Reserves not only for such lands as belonged to Government and of tribal, stool and private lands at the request of the owners, but of lands in respect of which it appeared to the Governor in Council, on the advice of the Commissioner of Forests, that the destruction of forests thereon is diminishing or likely to diminish the water supply or is injuring or likely to injure the agricultural conditions of the neighbouring lands or is imperilling the continuous supply of forest produce. The Ordinance lays down the procedure for demarcation and the settlement of the claims involved through a Reserve Settlement Commissioner. Amendments, particularly the Ashanti Forest Ordinance (Ord. 1 of 1931), have introduced no new principle.

It will be observed that, in all this discussion, the agricultural aspect of land is not prominent, a fact due to the dual reason that in these afforested regions agriculture was of small importance both as a native industry and as affording an opening for aliens. It was for mining and timber that concessions were mainly sought. Nevertheless, a certain alien interest arose in the case of palm oil though this partook more of the nature of a forest product than of recognised agriculture, while the rapid development of cacao gave a growing importance to the question of permanency of tenure to the native cultivator. The former, in as far as the Concessions Ordinance failed to meet the case, was met by the Palm Oil Ordinance (Ord. 10 of 1913) under which the Governor was empowered to grant exclusive right to erect and work mills driven by mechanical power if satisfied that the majority of tribal authorities and of owners approved. Among the limits imposed by this Ordinance were, a circle not exceeding 10 miles in radius and a period not exceeding 21 years. Rights in land are specifically excluded while, to prevent an aggregation of units, a transfer to anyone having a similar grant within 50 miles of any part of the transferred area is prohibited. An example of the form of contract is given in the correspondence published in Cd. 6673. The demand for agricultural concessions by aliens has never constituted a serious problem in the Gold Coast and the major agricultural aspect of the land question concerns the native holder.

The native conception of land tenure in the Colony and Ashanti was typical of that held in an unadvanced community where land is abundant even if densely afforested and requiring much labour to clear. No very clear system had been built up and, beyond a recognition of communal ownership with administration by the chief and of the right to a member of the tribe of access to the land, the various rights were ill-defined. There was still a semi-religious aspect, the chief being both trustee for ancestral property as well as for the tribal unit and, as trustee, he could not alienate this property. The general unit was the family, not the individual, which held its somewhat nebulous title, nebulous as to area and permanency of tenure, from the chief. Unallotted lands formed the background of tribal property while a third form of landed property existed in 'stool' land, in essence the personal estate of the chief in his capacity as head of a family. Under the impact of external forces this primitive attitude towards land is changing and very different stages are to be found in the evolutionary process according to the nature and strength of that impact. Near the coast, as has been said, English law has come to be applied, individual rights in land with freedom of transfer have been generally recognized and disputed cases are settled in the Judicial Courts. Further inland the pressure has arisen from the rapid extension of cacao, land is becoming scarce and a perennial crop requires some guarantee of permanency of tenure. In these areas land is attaining a commercial value and there is developing that pressure which must lead to the inevitable breakdown of the indigenous system. Though the matter has not yet developed an importance demanding what may loosely be termed tenancy legislation, signs of a conflict of interests have not been wanting. Judicial decisions by which land questions were settled have laid down, first, with regard to unoccupied land, that all land which lies within the recognized boundaries of a sub-stool belong to that sub-stool; secondly, that, in cases of long occupation or of the cultivation of perennial crops (sugar-cane and cacao) as opposed to shifting cultivation (yams, plantains, &c.), the presumption is that occupation is with the consent of the stool (6). It was clearly necessary to anticipate matters and, by survey and registration of titles, to demarcate the boundaries of the various interests which, under native custom, had never been clearly defined. In this matter some progress has been made for, in 1922, a Survey Ordinance (Ord. 9 of 1922) was passed which, however, has a limited application as a solution of the question, for Section 32 lays down that the Ordinance does not affect land titles in any way. Registration of titles has never been enforced, the Land Registry Ordinance (Ord. 1 of 1895) merely providing facilities for optional registration.

The Judicial decisions referred to above, however, hardly touch on the question of the small individual holdings which has assumed so great an importance since the introduction and spread of cacao. If they have determined that a perennial crop confers permanency of tenure, they are silent on the question as to what return should be made to the chief for that right. Custom, too, hardly provided an answer for, under it, the chiefs could claim only

an odd day's labour or a load of rubber. A new custom was required to meet the special case and the payment has now been fixed at one-tenth of the cacao crop. The tendency of recent legislation, however, has been to re-establish as far as possible the application of native custom in all matters pertaining to land and, in Ashanti, all suits relating to ownership or possession of land held under native tenure are dealt with under the Ashanti Native Jurisdiction Ordinance (Ord. 4 of 1924). In the Colony the Native Administration Ordinance (Ord. 18 of 1927) defines the position even more specifically. It brings within the jurisdiction of the Chief's Tribunal all suits relating to the ownership, possession or occupation of lands within his state or division with the qualification that the consent of the parties must be forthcoming where it appears that, either from express contracts or from the nature of the transaction, the parties expressly or by implication agreed that their obligations should be regulated according to the provisions of some law or laws other than native customary law, or where some other law or laws is or are properly applicable thereto. In such cases Section 75 gives appeal to the Provincial Commissioner's Court. Further, in the case of any land dispute between Chiefs, the Provincial Councils concerned, sitting jointly, have jurisdiction in the matter under dispute with appeal to the Full Court of the Supreme Court.

The Northern Territories offer a very different aspect of the land question to that just considered. Their situation exposed them to the Moslem forces which in the Middle Ages, attained supremacy over the tract lying south of the Sahara. To these forces the inhabitants were in no position to offer serious opposition. Too distant, also, to be absorbed effectively as were the races inhabiting Northern Nigeria and for the Moslem religion to be imposed, they were exposed to the full force of the slave raiders with the result that only a sparse and disorganized population survived consisting of small, independent units, in many cases hardly larger than the family. No central authority, such as was found in Ashanti, was in existence at the time of the British occupation. These communities had suffered a process of disintegration which only the Pax Britannica arrested. Land existed in abundance and the conditions were such as were calculated to hinder the evolution of any clearly defined native land system. Further, the country, both climatologically and geologically, offered few attractions to the alien either for agriculture or mining. Consequently Government has been able to work out and apply a settled land policy free from the insistent pressure of practical issues such as faced it both in the Colony and Ashanti. Under the Northern Territories General Administration Ordinances (Ords. 1 and 2 of 1902) the District Commissioners were entrusted with the power to decide land cases and, under the protection so offered, Government has been able to follow a leisurely policy which has been one which has, with time, more and more definitely crystallized round the modern practice of administration through the native organization. The major legislative step early taken was embodied in the Mineral Rights Ordinance (Ord. 2 of 1904), being the counterpart of the Concessions Ordinances of the Colony and Ashanti but of narrower scope.

The early difficulties with which the Administration was faced, arose from the disorganized state of the country. From the scattered units had to be built up some semblance of larger, tribal units which would form the basis of the administrative organization; the details of the land policy could be left for later solution, the natives in the meantime being left to follow such local custom as existed. That custom was of the most primitive nature. With the religious background common among such primitive peoples, land was considered communal property and authority with regard to it was vested in the chiefs where these existed or in the heads of the family groups. In the absence of any pressure on the land, occupancy constituted a right and even alien settlers were permitted to take up land unmolested provided they conformed to tribal custom. Payments by the cultivator to the chief partook more of the nature of presents than of fixed dues.

Meanwhile, in Northern Nigeria, where a much more highly developed native organization was in force, serious efforts had been made to evolve a practical policy of administration through that organization. In 1912, after the Belfield Report had been published and failed to provide an acceptable solution, the Secretary of State for the Colonies appointed the West African Lands Committee with instructions to report on the applicability of that system to other West African Dependencies. The labours of that Committee were interrupted by the War and no report was published. A large amount of information was, however, collected and is available*. In 1927 the Government policy towards land in the Northern Territories as it had been gradually built up, was formulated in the Northern Territories Land and Native Rights Ordinance (Ord. 1 of 1927). The objects of this Ordinance, as defined in the preamble, were as follows:—

(1) to protect the customary rights of the natives.
(2) to preserve as far as possible customary law.
(3) to define the rights and obligations of Government and cultivators.

There is here, following the Northern Nigerian precedent, a definite acceptance of the modern conception of the administration of such territories but, to avoid any doubt such as had exercised the authorities of the Gold Coast in the case of the Colony and Ashanti, it is laid down in Section 3 very specifically that the whole of the lands are declared public lands with the qualification that the validity of existing titles will be recognized if proved within three years. Further, under Section 6, a certificate of title of occupation is to be given the form of which is laid down in Section 12. The title may be for any term subject to the limit of 99 years. The powers of the Governor to enforce rents is limited to towns; in the case of

* Much of the information here given is derived from that source.

existing towns payment of rent is to be by non-natives only but in new towns payment may be demanded both from natives and non-natives. Power to revise rents is granted at intervals of not less than three years in thecase of land allotted for general purposes and of not less than twenty years in the case of land leased for building purposes. In the case of non-natives areas over 5,000 acres require the approval of the Secretary of State. Rights of occupancy confer no rights to minerals and it is rendered unlawful for a native to alienate any estate, or an occupier to alienate his rights of occupancy, to a non-native. Devolution of the rights of an occupier on death are to be regulated by native customary law and subject to division only with the consent of the Governor. This Ordinance has recently been superceded by a later Land and Native Rights Ordinance (Ord. 8 of 1931) which, while maintaining the same policy, makes some noteworthy alterations. In this Ordinance all lands, with the same qualifications, are declared to be 'native' lands and are at the disposition of the Governor for use or common benefit of the native. The terms of occupancy tenure are maintained but now no limitation is placed on the Governor's power to exact rent; he is, however, authorized to issue occupancy rights free of rent or at a reduced rent if in the public interest provided no grant for over five acres is so given without the sanction of the Secretary of State. All rents derived from non-natives holding occupancy rights outside towns are to be paid to Government but an amount to be determined by the Governor, but not less than one-half, is to be remitted to the native authority. Further powers conferred on the Governor by the Ordinance are for regulation of the registration of rights of occupancy and transfer, of transfer by sale or otherwise, of the procedure to be observed in the revision of rents and of survey and demarcation. The land policy of the Northern Territories, thus, differs fundamentally from that of the Colony and Ashanti and not the least point of difference lies in the fact that land cases are removed from the purview of the Judicial Courts.

Throughout the Gold Coast there has now arisen a system of production based on small holdings and, as in East Africa, many practical problems arise as to how to render that system effective in the case of exchange cultures the produce from which finds its way on to the world's markets. The major product of the Gold Coast is cacao followed by kola nut and palm oil, the last two being mainly the product of wild trees. In the case of cacao and palm oil the problem centres in the methods of preparation after the fruit has been gathered and it is noteworthy that both products are graded low on the world's markets. Of interest here are the steps which have been taken to rectify this defect as well as to control native production generally. Action in this direction is limited and has not developed to the extent found in East Africa. In 1923 a Pests Ordinance (Ord. 37 of 1923) was enacted which, though mainly permissive, conveyed extensive powers of control on the Governor. Plants subject to control must be declared and the Ordinance declares cacao, cotton and rubber while it gives the Governor power to add to the list. He is also empowered to declare diseases while inspectors may be appointed to carry into effect the terms of the Ordinance. Inspectors are authorized to enter any farm and, in the first instance, to apply such remedy as may be prescribed under the Ordinance. Subsequently it becomes the duty of the occupier to continue the application of the remedy and rules are laid down for the procedure in the event of his failure to comply with the terms. In 1926 (Ord. 44), in addition to the inclusion of kola and bananas, a number of diseases of cacao were declared with their remedies and a number of inspectors appointed. In addition to this internal administration under the Ordinance, importation of plants was brought under control with a system of licences from the Director of Agriculture which covers not only the plants themselves but the wrapping material as well as the soil.

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(1) A Tropical Dependency, Lady Lugard, 1905.

(2) A Historical Geography of the British Colonies, Vol. III, Sir Charles P. Lucas (3rd Ed.), 1913.

(3) Report upon the Customs Relating to the Tenure of Land in the Gold Coast, 1895.

(4) Report on the Legislation Governing the Alienation of Native Lands in the Gold Coast Colony and Ashanti. H. Conway Belfield, Cd. 6278, 1912.

(5) Accts. and Papers, 1913, 45, p. 693.

(6) Ann. Rept. on the Gold Coast, 1910; Cd. 5467, Accts. and Papers, 1911, 51, p. 289.

THE ANNATTO.

The Annatto* or Roucou (*Bixa orellana*) is a native of South America which has become naturalized in many parts of the tropics. It is a tree growing up to 20 ft. in height, with heart-shaped leaves, pink flowers in terminal clusters and a heart-shaped, scarlet fruit which later turns brown and splits in two. Its commercial value lies in the seeds which produce a reddish dye used in colouring varnish, edible oils and other foodstuff, also in dyeing silk. The seeds sold locally in Trinidad fetched 12 cents per lb. and there is a probable market in Canada. It can be cultivated by following the ordinary methods for tropical tree crops, *i.e.*, mulching, cover cropping, &c. Propagation is by seed, the tree bearing in its second year. The plant might make a useful shade tree for coffee, when its seeds could be utilised as a catch crop, which would bear twice a year. To prepare for market, mature pods are picked and dried in sheds. When dry they are beaten with mallets to extract the seed, which is cleaned by sifting through suitable riddles. The extracted seeds are dried for a further three days.

*Llanos, M. *Proc. Agr. Soc. Trinidad and Tobago*, 1932, 32, 191-97.

AUXIMONE NUTRITION.

Do Plant Growth-Promoting Substances Occur in Soil Organic Matter and Organic Manures?

By F. Hardy.

[*Note:—The recent multiplication of field experiments, designed to compare the relative merits of organic manures and artificial inorganic manures, has aroused considerable interest in the possible significance of factors other than the direct effect of nitrogen-phosphorus-potassium nutrition which may contribute to the final result. Among these accessory factors, "auximones" have been invoked to explain, at least in part, the special virtue frequently attributed to organic manures. In the following article, investigations on "auximone nutrition", that have been prosecuted by various workers since the question was first raised in 1914, are reviewed in some detail.*—Editor.]

The possible significance of certain accessory food substances for normal plant growth was first stressed by Professor W. B. Bottomley, of King's College, University of London, in a series of papers that were published in the *Proceedings of the Royal Society of London* from 1914 to 1919 (1, 3, 4, 5, 7), and in other journals (2, 8). Bottomley was searching for a material rich in soluble humates, suitable for culturing nitrogen-fixing organisms. He found that, when peat is treated with certain aerobic soil micro-organisms, it yields large amounts of soluble humate. This "bacterised peat", after being carefully sterilised, was found to be an excellent medium for the purpose intended, and, moreover, "it possessed a certain growth-stimulating property" (for various plants grown in soil and in water cultures) "which could not be accounted for by any known manurial constituents present" (2). The name "auximones" was proposed for the growth-promoting substances apparently contained in the material (3), and it was suggested that they resembled vitamins now known to be essential to the proper growth of animals. Bottomley experimented next with Duckweed (*Lemna minor*) a small, floating water-plant of simple structure, which can be grown readily in water culture, and which reproduces itself by budding (4). His observations led him to conclude that bacterised peat contains certain organic substances (auximones) which exert a marked stimulating effect on *Lemna* growing in complete mineral culture solution, even when they are supplied in very small quantities, and that normal growth and reproduction in *Lemna* cannot proceed for any length of time in the absence of these substances. Bottomley took out several patents for the manufacture of growth-promoting substances from bacterised peat, and great success is reported in many cases where the material was used in greenhouses and market gardens. Bottomley's laboratory methods were next applied by his pupil, Miss Mockeridge, to a study of the growth of soil micro-organisms concerned in the nitrogen cycle (6). It was found that auximones increase the rate of nitrogen-fixation and nitrification, so that they are apparently also essential to these forms of bacterial life at least. Mockeridge later suggested (9) that auximones are actually manufactured by certain soil bacteria and moulds, but that, in the case of the higher green plants, they must be supplied from some outside source, namely, organic matter in which bacteria have been active. Bottomley's later work (5, 7) indicated that derivatives of nucleic acid, which can be extracted from raw peat, act in similar manner to auximones, and Mockeridge (17) further substantiated this observation by showing that auximones increase the size of the cell nuclei of treated plants.

The findings of Bottomley and Mockeridge were challenged in 1924 by Dr. N. A. Clark and Dr. E. M. Roller of Iowa State College, U.S.A. (15,16), who employed mineral solutions of somewhat different composition from those used by Bottomley. Their initial experiments indicated that *Lemna* will grow and multiply for a considerable period of time in the *absence* of organic extracts, provided mineral mixtures exactly suited to the requirements of the plant are used. They maintained therefore that "auximones are not essential for the growth and reproduction of green plants, and cannot be classed with vitamins", but that they may still function as accelerators, in the way that "bios" accelerates the reproduction of yeast (10, 11, 12, 13, 14). Mockeridge had indeed already indicated this similarity between auximones and yeast bios. Clark and Roller's subsequent work stressed the importance of proper illumination in conducting growth experiments with *Lemna* (18), and of a suitable reaction (pH value) of the mineral culture solution (20).

In 1926, Dr. H. S. Wolfe of the University of Chicago, U.S.A., reviewed the auximone question (19), and presented further experimental results which supported Clark and Roller's opinion that the culture solutions employed by Bottomley and Mockeridge lacked proper "physiological balance". Wolfe therefore recommended that the term "auximone" should no longer be used, "since "auximones were hypothecated as absolutely "indispensible for the continued healthy growth "of a plant, and not simply as capable of increasing "growth. Whether, in a physiologically-balanced "inorganic nutrient medium, it is possible to "stimulate growth still further by the addition of "organic substances, is beside the question."

Perhaps the most detailed study of *Lemna* and the influence of various factors upon its growth and reproduction, was undertaken during 1928-29 by Mr. E. Ashby, of the Imperial College of Science and Technology, London (22). Ashby also confirmed Clark and Roller's observation that *Lemna* can grow and multiply for indefinite periods in a purely inorganic medium. In his experiments, he took precautions suitably to control growth factors, and to prevent bacterial infection and contamination of the cultures. Moreover, he measured

growth, not only by counting the number of individual plants that developed, but also by determining dry weight, carbon content, and frond area. Further, the results obtained were subjected to statistical analysis. The source of organic material added to the cultures was fresh horse dung. The extracts used were previously sterilised by heating. From an analysis of the data obtained under these controlled conditions, Ashby concluded that "the minute amounts of organic "extract added (0.2 parts per million of culture "solution) had a significant influence upon the "growth rate" of *Lemna*, causing a particularly marked increase in frond area. The effect was not due to an enzyme, because autoclaving the extract did not impair its potency. "The increase in "growth rate must be due to some catalytic action "of the organic matter, and not merely to a "quantitative effect of the minute amounts of "nitrogen added". The chief effect was an increase in the number of chloroplasts in the frond-cells of the treated plants. It is evident therefore that "organic matter is *not* essential "for the growth of *Lemna minor*, but that "minute quantities, when added to an inorganic "solution, do increase the growth rate to a "striking degree . . ."

This important contribution to the subject, and these conclusions, however, have not been left unchallenged. In 1930, Clark (23) criticised Ashby's experiments, mainly on the grounds that he did not free his *Lemna* plants from bacteria before introducing them into his sterilised culture solutions. Later, Clark and Roller (25) published their further experimental results in detail. Under non-sterile conditions, they found, as the early investigators had found, that "small quantities of "organic extracts added to a variety of inorganic "solutions can stimulate the reproduction of "*Lemna*, not only under unfavourable conditions, "but also at the pH which is an optimum for the "growth in the inorganic solution," but that "the "addition of organic matter invariably increased "the number of micro-organisms in the nutrient "medium." Consequently, Clark and Roller repeated their experiments, but took particular care to conduct them under completely sterile conditions, so that "the direct influence of organic "extracts could be studied free of bacterial action." They used potassium mercuric iodide or bleaching powder for sterilising the *Lemna* plants. They obtained good growth with the sterilised plants placed in suitable sterilised mineral nutrient solutions under suitable environmental conditions. Next, they added extracts of soil and of organic manure, sterilised by autoclaving. They found that, under these fully sterile conditions, organic matter failed to stimulate the reproduction of *Lemna*; indeed, in many cases it actually depressed the rate of reproduction. Usually, however, re-inoculation with pure cultures of certain bacteria, or with micro-organisms from non-sterile *Lemna* plants, or from soil or manure, increased the rate of reproduction.

So far, it is evident that the stimulating organic substances (auximones) that accelerate the growth and reproduction of *Lemna*, but are not essential to these processes, are apparently manufactured by specific micro-organisms, many of which occur in stagnant ponds, soil, organic manures and leaf mould. As Waksman states in his recent book, *Principles of Soil Microbiology* (1931, p. 765), "we must recognise the fact that, under certain "conditions at least, the presence of decomposed "organic residues and of microbial cell substance "is of considerable importance in favouring growth "of plants and micro-organisms," but that "the "production by micro-organisms of plant-stimu-"lating substances, or 'auximones,' is still a "matter of conjecture."

There is still another important aspect to the question of the stimulating effect of soil organic matter and organic manures; this further concerns the chemical nature of the stimulating substance. Although Clark and Roller (25) and Wolfe (19) have shown that certain pure organic substances (such as asparagine, alanine, caffeine, pyridine, urea, acetamide and creatinine) exert little or no stimulating effect on the growth processes of *Lemna*, C. Olsen (24) has claimed that *Lemna* and Sunflower will grow equally well in suitable culture solutions, even when no "humus extract" is present, provided that *ferric citrate* is added. If *ferric chloride* be substituted, and the reaction of the culture solution is alkaline or neutral, ferric ion may be precipitated. However, if humus extract is used in addition, this result may not occur, because humus interacts with ferric salts to form complex organic anions of iron, which are readily absorbed by plant-roots. The precipitation phenomena of iron and aluminium in soil and water cultures has elsewhere been discussed in a paper by the writer (21), in which it is concluded that toxic aluminium-ion and ferric-ion are precipitated as hydrous oxides at reaction values lying between pH 4.7 and pH 8.5, whereas the complex organo-ions (*e.g.*, ferri-oxalate, ferri-tartrate) show no precipitation over this range.

An extensive study of the iron factor in especial relation to the stimulation of *Azotobacter* has been very recently described by Messrs. D. Burk, H. Lineweaver and C. K. Horner of the U. S. Department of Agriculture (26). These investigators criticise Olsen's conclusions on the grounds that he failed properly to control his experimental conditions. In their own elaborate experiments, they took every precaution to ensure that their data were comparable. On the basis of a number of independent lines of evidence, they showed that "humic acid" causes stimulation of *Azotobacter* growth primarily by virtue of its iron content, and that natural humic acid may be replaced more or less satisfactorily by ferri-citrate, ferri-tartrate or ferri-oxalate, or even by inorganic iron salts, such as ferric sulphate, although in this case, stimulation is tardy and least satisfactory, and necessitates a very long induction period. Hence humic acid appears to be both a nutrient which provides iron for growth and a stimulant which

provides iron in a highly available form. Although these conclusions apply strictly to *Azotobacter* and not to higher green plants, Burk, Lineweaver and Horner believe them to be generally applicable. They claim that their results may partly explain Clark's finding that growth stimulation of *Lemna* by organic extracts occurs only in the presence of contaminating organisms which presumably, therefore, can assimilate iron and convert it into a form which is rapidly available and stimulating to the growth of higher green plants. This view, then, stresses the great significance of small amounts of certain mineral substances in appropriate combination. It is interesting, therefore, finally to note in this connection that Dr. O. W. Richards has just published an important paper (28) in which he claims to have demonstrated spectroscopically, that thallium is one of the growth stimulants (bios) for yeast, and that Elvehjem (27) has also shown that yeast growth is very poor in the absence of traces of iron and copper. Until more is known of the exact chemical composition of the various growth-promoting substances that apparently occur in natural media, further speculation as to their probable mode of action would appear to be unwarranted. It is conceivable, for instance, that the stimulating effect may be due to some *specific* component of the growth-promoting substance which may differ in different cases. Thus, the growth-promoter may act in some cases because of its content of suitable iron compounds, in other cases, because of the presence of aluminium, or of copper, &c., in others, through the presence of silica or phosphate, or by adding a protective agent against poisons, or by increasing the availability of essential elements, as well as, in some instances, by actually adding a purely organic stimulating substance. Doubtless further research will indicate how far such specificity in growth-promoting substances can be invoked to explain individual examples of stimulation in different sorts of plants. The results of further research in this domain will naturally be awaited with great interest by agriculturists.

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JAVA GRASS.

Good lawns are difficult to establish and mantain in many places in the tropics. In the West Indies, Devil's grass or Bahama grass (*Capriola dactylon*) is much used as a lawn grass in the drier islands. In Trinidad, the Savannah grass or Carpet grass (*Axonopus compressus*) is generally the more used for this purpose. In 1924, Java grass (*Polytrias praemorsa*) was introduced into Trinidad, where it has found considerable favour as a lawn grass. A well-grown lawn of Java grass is really beautiful. The deep green of the foliage, the soft effect of the narrow, delicate leaves, and its evenness, combine to give a very pleasing effect. The leaves are very finely pubescent, and, in consequence, they hold the dew until well on to the middle of the day, even under a full tropical sun. Java grass is easy to grow from cuttings and roots, covering the ground evenly and quickly, and when established it can be maintained as a smooth, close trimmed lawn. In Puerto Rico it is said to seed freely, and in that island it has been found useful in pastures as well as for lawns. Under Trinidad conditions, however, Java grass is not a perfect lawn grass. It suffers from the effect of the sun in very dry weather, and from excessive moisture in a very rainy season. In a severe dry season, Java grass may turn brown and even die out in patches, if exposed to the sun for the whole day. Portions of a lawn shaded by a tree or building during a part of the day will remain beautifully green. In the wet season, in low spots where the water gets away slowly, the Savannah grass will often come in and crowd out the Java grass, which also is affected by dense shade and the drip from the branches of trees. In the ordinary wet and dry seasons in Trinidad, Java grass would seem to be generally very suitable as a lawn grass. There have been, however, one or two complete failures with this grass for which no explanation has been found. It may be added that Java grass is not immune from attacks by the mole cricket and the chinch bug.

H. A. B.

WEST INDIAN NOTES.

(Compiled by the Advisory Department of the Imperial College of Tropical Agriculture.)

General.

The Windward and Leeward Islands have passed through the dreaded hurricane season of 1932 without any really serious damage. A cyclonic disturbance, however, passed North of St. Kitts on the 26th September which caused the barometer to fall to 29.60 inches. Heavy winds were experienced and the tall canes, especially the Java variety P.O.J. 2878 suffered extensively, being uprooted. For this reason alone this variety is proving unsuitable to West Indian conditions. Its early arrowing, late suckering and high susceptibility to moth borer attacks are added disadvantages. During November the hurricane which did so much damage to Jamaica, the Cayman Islands and Cuba originated to the west of these Islands, but beyond causing a heavy ground swell, did little damage.

The prospects for the 1933 sugar crop are excellent, ample rains having fallen everywhere with the possible exception of Trinidad. For other crops the rainfall has been rather excessive especially during the latter half of November. This has caused a serious check to the vegetable industry of Montserrat and has made the drying of cacao difficult in St. Lucia and Dominica where good crops are anticipated. Heavy rains have delayed the commencement of the reaping of the large arrowroot crop expected in St. Vincent.

The area under cotton in St. Vincent, Nevis and Barbados is very much reduced and is below the quota approved by the Barbados Conference. The germination and subsequent growth of the crop is satisfactory and in St. Vincent, where close attention is now being given to the question of seed supply, the uniformity of the stand is remarkably good and is in sharp contrast to the conditions prevailing three years ago. The excellent results that have followed the re-opening of the Cotton Research Station in St. Vincent which was made possible by the generosity of the Empire Cotton Growing Corporation, have stimulated the arrowroot planters to create a similar organization to look after the interests of the arrowroot crop. The marketing of arrowroot has already received attention but much research work is necessary for the improvement of the field and factory practices and the newly appointed scientific officer will be engaged on these aspects of the problem.

* * *

The Fruit and Vegetable Industry.

The most recent statistics reveal that the mango exports were slightly below last year's, St. Lucia and Dominica exporting some 4,000 and 1,100 miscellaneous crates respectively, as compared with some 4,500 and 1,300 in 1931, the decrease being due largely to the smaller crop.

Shipments of avocado pears have, however, increased considerably this year. The exports have been made mostly to Bermuda: small shipments to Canada and England have met with indifferent success. The increased shipments are well illustrated by the following figures of the exports for the last two years.

Island.	1931 to end October. (crates)	1932 to end October. (crates)
St. Lucia ..	2,281	4,256
Dominica ..	638	1,640
St. Vincent ..	417	769

As shown below, exports of oranges and grapefruit from Dominica will reach another record figure this season:

1931-32 season. total crates.		1931-32 season to end Nov., 1931. (crates)	1932-33 season to end Nov., 1932. (crates)
Oranges	2,742	855	1,902
Grapefruit	2,015	667	1,763

At the time of writing* a further 800 crates were awaiting shipment and the peak period was not passed. Shipments have been made principally to Canada and gross prices to date ranged between $3.00 and $3.50, the oranges bringing slightly higher returns than the grapefruit. Bermuda shipments of some 300 cases per month, mostly oranges, have been sold at around 19 shillings, an approximately similar return. The increased exports are principally due to increased crops following improved cultural conditions in the two principal bearing estates established some 15 years ago, and to a lowered cull percentage due to better handling and transport. The plantings in recent years in Dominica and St. Lucia are only just beginning to bear. St. Lucia shipped 166 cases of oranges and 55 cases of grapefruit this season up till the end of October, almost entirely to Bermuda, the orange export being mostly of seedlings.

Recent weather conditions in Montserrat have unfortunately been very bad and thus the attempt to produce a fair quantity of tomatoes for the early market has not been very successful. The Botanic Station rainfall is a rough average for the tomato growing sections of the island, and during the period 1st September to 20th November, the rainfall recorded there was 20 inches over the average for the past five years. This has caused much loss from washing out, disease and excessive vegetative growth, and also from fungal wastage after packing. Some 860 crates have been shipped to date, whilst none had been shipped at this time last year, but given normal weather conditions the exports would have been much larger. The first gross sales made realised $1.50 for "Choice" (2¼ to 2¾ inches) and $1.25 for "Gems" (1¾ to 2¼ inches): very little of the fruit so far is "Fancy" size. St. Vincent has been growing a small quantity out of season for Bermuda shipment, but exports will be generally smaller this season. Other than Montserrat, Nevis is the only Leeward Island planting any considerable acreage and its exports should total around 5,000 crates.

* 2nd December.

* * *

The Lime Industry.

Information has come to hand from several sources that manufacturers of citrate of lime are not likely again to have resort to lime and lemon juices in the manufacture of that chemical. It is now generally known that citric acid is produced from sugar and sugar bye-products, the users of citric acid obtaining their supplies at very cheap rates from these sources. The manufacture of concentrated lime juice must therefore be regarded as a thing of the past. This is a very serious matter for islands such as Dominica and St. Lucia and one that should be carefully considered by planters and others.

The chief remaining product of the lime is the essential oil and of the two kinds, the more important is that produced by the distillation of the raw juice. Recently complaints have been received that some of the shipments of distilled oil have been unsatisfactory and several parcels have been rejected. Great care should be taken to ensure that oil of the finest quality is produced and, if necessary, the oil should be graded, inferior qualities being shipped separately. Carelessness in this respect may mean serious loss to the shipper and permanent injury to the trade. Quality in lime oils is largely a question of odour and planters should make a special study of the fine differences to be detected when small quantities of different grades of oils are placed on strips of blotting paper.

The following procedure is followed by a planter who has made a special study of this subject. Sound yellow limes are crushed in the usual way and the juice strained and stored. When sufficient has been accumulated the juice is placed in a perfectly clean still and the distillation process is carried on slowly until about 90 per cent. of the oil has come over. The remainder is then collected and shipped separately. Green limes are excluded and partially decayed limes are crushed the juice being distilled separately and the oil shipped in its own grade. Lime seeds are carefully excluded and the still is cleaned after each distillation. The oil collected should be kept in bottles until sufficient has been obtained to fill a tin. Bottles of oil should be kept in the dark, as exposure to light and air soon causes deterioration.

Fresh Limes.—Definite progress has been made during the past season to popularise the lime in Canada and the Marketing Officer has arranged

for small regular shipments to be made to several agents in Canada. The tomato lug carrying some 200 limes makes a convenient and attractive package. In view of the loss of the concentrated juice market the question of finding new markets for fresh limes becomes even more urgent.

* * *

The Grapefruit and Orange Industry.

The 1932 season for oranges and grapefruit has commenced in Dominica. The Trinidad crop is earlier than usual and Mr. Anderson has arrived in the Island from Florida to take care of the co-operative packing house. Judging from the returns of plant distribution received from the various islands grapefruit growing is being extended and arrangements are being made to raise grapefruit plants on a large scale during the next few months. Great improvement in the quality of the plants sent out from Government nurseries is to be recorded especially in St. Lucia where special attention is being given to the formation of the future trees in the nurseries. Most of the carefully selected citrus trees imported into St. Lucia from Florida in 1928 are now bearing fruit. Fruit of excellent flavour has been produced, and budwood from these selected trees will be used for future work.

* * *

The Pink Bollworm.

The remarkable increase of pink bollworm (*Pectinophora gossypiella*) throughout the West Indies during 1931 has emphasized the seriousness of this insect's attacks under certain conditions. For several years previously cotton growers had suffered very little loss from attacks of the pink bollworm, so long as they reaped only the so-called first crop of plants and made no attempt to get a second bearing. In 1931, however, pink bollworm caused considerable damage even to the first crop. It is believed that this was mainly due to the effects of unfavourable climatic conditions. In the case of early planted cotton in Montserrat and St. Kitts dry weather interfered with the planting of the crop and thus lengthened the planting season unduly. Unusually heavy rains in the latter part of the year affected the ripening of the early cotton and thus interfered with the development of the young crop, and causing the loss of the first bolls and a spread of the reaping season. This gave the pink bollworm a longer season in which to injure the bolls.

The cotton leaf worm (*Alabama argillacea*) was also abundant and its depredations in many instances further injured the plants, while frequent rain showers washed off poisoned sprays and made control impossible.

During 1931 entomologists from the United States Department of Agriculture visited St. Croix of the United States Virgin Islands and surveyed* the status of the pink bollworm in that island. Notwithstanding the fact that no commercial planting of cotton had been made in the island for several years, "wild cotton" was found widely distributed over the whole island, pink bollworm being abundant in this and other host plants. The "wild cotton" was most probably escaped Sea Island Cotton from previous cultivations, and also tropical American wild cottons which exist in St. Croix as in the adjoining islands. The other host plants which were found to be harbouring pink bollworm were okra (*Hibiscus esculentus*), (*Thespesia populnea*) which is known in the British West Indies as "John Bull" or mahoe, and *Hibiscus vitifolius*, a common weed along roadsides and in pastures in St. Croix. As it was decided that the eradication of pink bollworm was impracticable, if not impossible, in St. Croix, a programme of a two or three-year close season was adopted for the destruction of the "wild cotton". This long-term close season has been tried in Barbados for the control of pink bollworm. It is now more than ten years since the pink bollworm became established in the West Indies and while the existing working arrangement for the control of this insect has in most years proved reasonably satisfactory no extensive research work has been done on its life history and bionomics. The system of cleaning up in the field after each crop, the destruction of all wild cotton likely to carry infestation, the daily fumigation of the seed at the ginneries and the selection of non-infested seed for planting have together insured a very high degree of control. The secondary food plants of the insect have been controlled for several years in the British West Indian cotton growing islands.

Further information is needed as to the resting-stage of this insect in the West Indies, since it is the resting-stage larva which, under ordinary conditions, carries the infestation over from one season to another. It is not known to what stimulus the insect responds when it enters the resting-stage. The recorded observations from Puerto Rico indicate that a small proportion of the larvae reaching maturity before October enter the resting-stage, while from October on, the proportion of the larvae entering this condition progressively increases. Observations on this point are needed in connection with early plantings (March) as in Montserrat and St. Kitts, and later plantings (July to October), as in other West Indian Islands.

* * *

Castor.

Enquiries have been made regarding the possibility of obtaining supplies of castor seed from the West Indies. In the past, efforts to develop a minor industry in castor seed, have not been very encouraging. There should, however, be no great difficulty in growing this crop provided the price offered for the seed proves satisfactory. For the first few years or until a sufficient quantity of seed is available to make it worth while to erect an oil extracting and refining plant, the Government Marketing Depots in the various islands

* Recorded in the 1931 Report of the Virgin Islands Agricultural Experiment Station Report (U.S.A. Dept. of Agriculture).

might be prepared to purchase from the peasants all seeds offering, provided the firm interested would give the necessary guarantee. It would be necessary to fix a minimum price for the seed in the islands and to establish a sliding scale system of payment which would vary with the market price. Meanwhile agricultural officers should take the opportunity of pointing out the possibilities of this crop to the peasants and advise them to plant a small area so that should a satisfactory offer be forthcoming the necessary seed supply would be available.

* * *

Miscellaneous.

Mr. H. B. Pidduck, Agricultural Officer, Dominica, resumed duty on 1st December.

* * *

Mr. E. A. Walters, Agricultural Superintendent of St. Lucia, returned from leave on 17th November.

* * *

Mr. H. A. Ballou, Commissioner of Agriculture, sailed for Barbados on 29th November, and returned to Trinidad on 15th December.

* * *

Mr. G. A. Jones, Assistant Commissioner of Agriculture, returned from leave on 3rd October. He left Trinidad on 1st November, and after paying official visits to St. Vincent and St. Lucia, returned to Trinidad on 29th November.

* * *

Mr. W. Campbell Roy has been appointed Agricultural Officer, Virgin Islands, and assumed duty on 12th September. It will be recalled that this office has remained vacant since the retirement of Mr. J. L. Illingworth in July, 1931.

* * *

Mr. A. C. Shill, Marketing Officer, paid an official visit to Trinidad from 18th October to 1st November. He returned to Dominica on 10th November after a few days stay in St. Lucia. Mr. Shill visited Montserrat from 18th to 24th November.

* * *

Mr. C. K. Robinson, who has been appointed as a special officer to investigate arrowroot problems arrived in St. Vincent on 2nd November where he was provided with temporary laboratory accommodation by the Agricultural Superintendent. Mr. Robinson returned to Trinidad in December and consulted with members of the College Staff on the various aspects of his work in St. Vincent.

* * *

Citrus scab which causes serious losses in nurseries has been the subject of further experimentation by Dr. Briton-Jones, Professor of Mycology at the College. It has been demonstrated that when sour orange seedlings are provided with overhead shade such as is given to young cacao seedlings the incidence of this disease is very much reduced. This information is likely to be of the greatest practical value to those responsible for the production of large quantities of budded citrus.

A course of lectures to overseers covering the syllabus drawn out for the use of those wishing to take a Home Reading Course in agriculture is being given by Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua. Mr. Warneford reports that twenty persons have registered as students and that about seventeen are attending the lectures.

* * *

The "Happy Valley" brand of shirts and underwear which are now obtainable in the large stores of Great Britain is guaranteed to be made of Sea Island Cotton. Recent visitors to England speak very highly of the quality and finish of these articles and it is hoped that they will meet with a ready sale, thus increasing the demand for West Indian Sea Island cotton.

* * *

An interesting experiment in vocational educational matters is being undertaken by the Wesleyan Church in St. Vincent. A new school is under construction on a small estate of some 30 acres where it is proposed to include in the curriculum, agricultural education, trade and industrial education for the boys, and home economics education for the girls. Mr. C. A. S. Hynam a former Diploma Student at the Imperial College, is to be in charge of the agricultural education. The Reverend Mr. Richards is to be the first Principal of the School.

* * *

The Government of St. Vincent recently purchased the Three Rivers Estate, a property of over 700 acres situated on the Windward side of the Island for the purpose of extending land settlement. The estate is now being surveyed and broken up into suitable lots. The Government of St. Vincent did a great deal in this direction in the early years of the present century and it has been responsible for the settlement of large numbers of people on their own land. The total area of purchased estates now exceeds 8,000 acres. Similar schemes have recently been undertaken in Antigua, Nevis and Anguilla.

* * *

The Commissioner of Agriculture has been informed that the cotton growers of St. Kitts have formed themselves into an Association of which Mr. A. M. Reid has been appointed Chairman and Mr. R. E. Kelsick, the Agricultural Superintendent, Honorary Secretary and Treasurer. Similar steps have been taken in Montserrat. In Antigua the Cotton Growers' Association which has been in existence for many years will constitute the local Association and in St. Vincent it has been suggested that the Agricultural and Commercial Society should form a sub-committee to deal with cotton matters and to carry out the duties of a Cotton Growers' Association. The formation of these local associations is a preliminary step towards the formation of a West Indian Cotton Growers' Association and was recommended by the Barbados Conference held in March last.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

ACADEMIC STAFF AND STUDENTS, 1932-1933.

First Row.—C. Lai-Fook, E. I. Hugh, A. V. Wan-Ping, E. A. Tai, S. Duncan, C. I. Imamshah, V. O. Ferrer, St. G. Cooper, B. de B. Darwent, J. M. McEwen, A. D. Herbert, A. Garces, H. M. James.

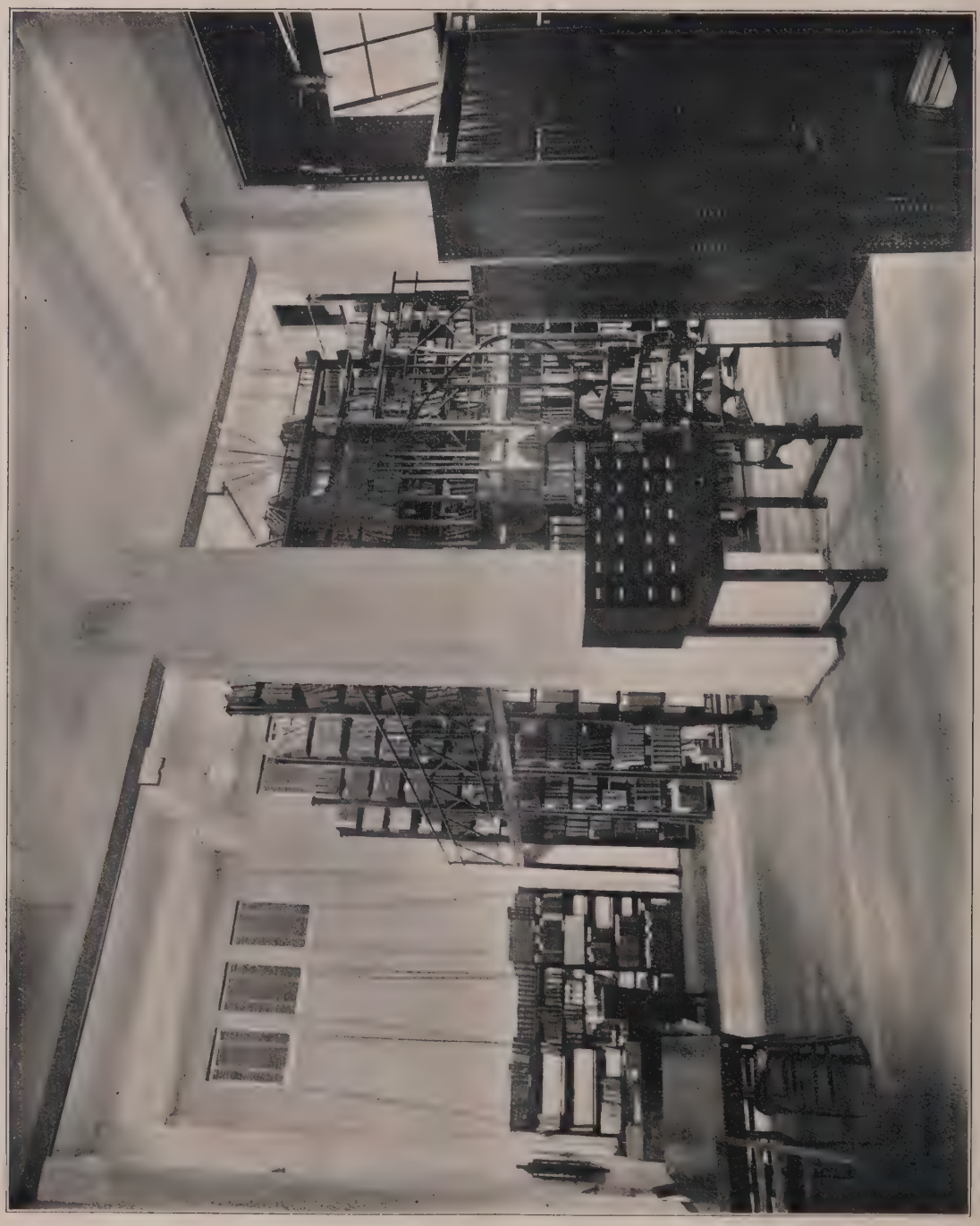
Second Row.—D. W. Duthie, L. A. Corbin, G. G. Gianetti, D. D. Paterson, E. E. Cheesman, H. R. Briton-Jones, H. A. Ballou, G. Evans, F. Hardy, R. C. Wood, C. Y. Shephard, F. W. Urich, J. R. Dickson, C. T. Watts, G. A. Jones, A. Pickles.

Third Row.—N. Wright, J. J. C. Buckley, E. E. Pyke, A. C. Shill, E. J. Butler, N. M. Wight, E. G. D. Pritchett, E. Williams, L. N. H. Larter, H. C. Thorpe, W. E. Freeman, D. F. Stewart, C. C. Webster, J. O. Torto, W. A. Tansley, J. G. Davies, F. J. Pound.

Fourth Row.—R. S. Bancroft, O. S. Milburn, C. H. Burgess, B. P. Campbell, M. Halcrow, J. Marshall, E. J. M. Shearer, R. W. Kettlewell, D. G. Whitelaw, J. Lamb, R. E. D. Baker, R. K. Kerkham, A. V. Coombs, C. Cameron.

Fifth Row.—R. S. Ball, W. I. Lee, H. C. Miller, A. E. Wyatt, T. E. K. Potter, C. G. Wigley, R. D. E. Yearwood, P. de Meillac, J. Cofie, M. S. Hassan, D. D. Sharma, R. Bally, M. Barcant, K. E. Toms.

Absentees.—A. K. Briant, L. P. McGuire, C. W. Wardlaw, P. E. Turner.



THE COLLEGE LIBRARY.

THE COLLEGE LIBRARY.

"In an Institution separated by miles of sea, journeys to consult libraries or for the borrowing of books are impossible. A fully equipped library, therefore, is a *sine qua non* of Research as well as of Post Graduate study and the provision of books and journals is, under the circumstances, a heavy item that is yet far from being fully met".

The extract above is reproduced from a leading article on "The needs of the College" which appeared in 1926 in the April issue of this Journal. Since this statement was made many changes have taken place and the College, thanks to generous gifts, both in money and publications, has been provided with a library worthy of its name. No library can ever be said to be fully equipped and the College library is no exception as there is undoubtedly room for much greater expansion. At the same time, however, the stage has been reached when many of the requirements in the way of books and periodicals have at last been met. This is the result of the work of all those who have, at one time or another, been closely associated with the welfare of the library. Little could have been achieved without them or the substantial funds contributed by the Empire Marketing Board and the Carnegie Corporation.

The nucleus of the present library was acquired from the Imperial Department of Agriculture when the functions of the latter were absorbed by the College. This nucleus of about 2,000 publications represented a valuable collection which was originally housed in the Old College Buildings. In September, 1925, this was moved into the New Buildings and housed in several stacks of wooden shelving which served for some years as temporary accommodation. After the move was made, the first step taken was to sort the publications of which none were catalogued, only one typist assisted by a boy being available to do this work. No cataloguing was possible until the beginning of 1927 when additional staff was secured to do this work. By the end of that year, however, the library had, to some extent, been reorganised and suitable systems of filing, cataloguing and classification had been introduced, while it was also possible to bind some of the literature.

In 1928, further progress was made and various changes were effected in the systems of cataloguing and classification. The binding programme was accelerated and a large number of urgently needed back sets of periodicals purchased. It was during that year also that plans were prepared for extending the accommodation to house the rapidly increasing number of publications. In July the first three stacks of steel shelving were installed.

Further progress was made in the years that followed. The collection of books and periodicals was steadily added to and the needs of the Staff and Students filled as far as possible. The binding of all back sets of periodicals and of the older books was completed. The cataloguing programme also progressed satisfactorily; there still remains, however, a number of publications to be dealt with. Additional accommodation was provided early in 1930, when five steel stacks were installed and again in October, 1931, when the scheme for installing a double tier of fourteen steel stacks with a glass flooring, balustrades and staircase was carried through. The whole of this steel structure, shown in the photograph accompanying this article, was purchased from Messrs. Sankey Sheldon. It has greatly improved the appearance of the library.

The latest census revealed that the library contained over 25,000 publications of which half are bound volumes. Nearly 500 different periodicals are filed, of which over two-thirds are received in exchange for the College Journal.

It may be stated in conclusion that the library with its present foundation of publications shows promise of becoming one of the most comprehensive reference libraries on tropical agriculture.

G. G.

ENTOMOLOGICAL NOTE.

Compiled by the College Department of Entomology.

Thrips and Apple Production in Australia.

The Bionomics and Economic Importance of *Thrips imaginis* Bagnall. By *J. W. Evans.* (Commonwealth of Australia, Council for Scientific and Industrial Research. Pamphlet No. 30, Melbourne, 1932.)

The apple crop in Australia is subject in certain years to heavy infestations of a thrips, which result in a serious loss brought about by the shedding of attacked blossoms. Such severe outbreaks, however, are not of annual occurrence and the author shows that the population in the spring is an accurate index of the severity of the damage to be expected. This in turn is dependant upon certain conditions obtaining during the previous autumn and winter, a heavy rainfall during these seasons favouring rapid increase of the thrips. The activities of the insect in the spring are also controlled by climatic conditions, temperature being the most important. No simple "remedy" against the pest is known, but the author shows that some measure of control may be brought about by applying insecticides just before the emergence of a large brood in a bad thrips year, which can be foretold by careful observations during the previous autumn. No opportunity has yet occurred of testing the use of repellants on a field scale, but the preliminary experiments on the use of sprays of dichlorbenzene and of a resin preparation are distinctly promising.

The ecological and physiological studies undertaken in this study are of particular interest and afford a striking explanation of the observed influence of climatic conditions on the abundance of the pest.

A. P.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

The Keeping Qualities of Raw Sugars. By *H. C. Prinsen Geerligs.*

Beet sugar can be stored for a long time, even for years, without perceptible loss in quality under the conditions specified by Claassen (1): "The keeping quality of sugar depends on infection of the syrup with fungi. Sugars having an alkaline reaction against phenolphthalein very rarely contain fungi, because a normal alkalinity is generally proof of sound and cleanly work. It is true that alkalinity is not an absolute remedy against deterioration and that alkaline sugar stored under unfavourable circumstances may lose in quality."

"A low and regular temperature and a low water content of the sugar are the best means to keep down action of fungi. The store should therefore be cool and dry. Storage of sugar in or over warm places, or in places where hot and moist air can penetrate, is to be avoided. In moist places sugar attracts water and may become so wet that syrup flows from the crystals and fungi attack it and cause inversion. In a cool and dry storeroom, syrup never parts from crystals provided that the sugar is well machined, even if its renderment be under 88°, as the molasses surrounding the crystals is so sticky at the low temperature, that it adheres as a skin to the sugar."

But in the case of the storage of cane sugars, matters are quite different. Such sugars should be made from syrups having a pH between 6 and 7 at 25° C. in a liquid of 40° Brix. density, and the product should be well spun off to a safety factor between 0.333 and 0.25 depending on local conditions. This massecuite should be dried if necessary, and should be cooled to atmospheric temperature before being bagged. In the store, even the best machined and best dried sugar may become moist and liable to fungi attack if the moisture content of the store be not kept low. In this connection one has to consider the very varying conditions in the many countries of cane sugar production. Thus the hot and moist climate of Java differs greatly from the temperate and dry one of Peru; while that of Cuba forms a good medium between these two extremes. In Réunion and in the Hawaiian Islands the windward side is much moister than the leeward.

"It is therefore obvious that conditions of storage which in one country are quite sufficient may be proved absolutely inadequate in others. We are told that in Cuba sugar may be stored in the open, only covered by tarpaulin, during a long time without any loss of quality, while from our own experience, we know that in Java the greatest care has to be bestowed on the construction of warehouses in order to keep out moisture during the rainy season. It is therefore unfeasible to give, in a general way, indications how to construct warehouses for cane sugar. Every country and even every part of any country has its own particular conditions. While in cool Australia a safety factor of 0.333 is considered as giving a safeguard, Browne (2) advocates one of 0.3 for Cuba and Porto Rico, and Honig one of 0.25 for Java, showing that the hotter the place the greater the danger of deterioration."—(*The Inter. Sugar Journ.*, Vol. XXXIV, No. 406, p. 402.)

(1) *Die Zuckerfabrikation*, 1918, p. 243.

* * *

Evaporation in the Philippines. By *William Wyllie.*

In endeavouring to increase the capacity of our evaporators we are taking the condensate directly from each cell (the old system) with an auxiliary cross-over connection leading from cell to cell, making sure that the condensate is thoroughly drawn off. With this arrangement the evaporators can be operated by either drainage system. The modern system, by installing baffles in evaporator calandrias, greatly increases the evaporative capacity and by thoroughly draining the condensate from each individual cell, we find greatly improved results.

It seems that one improvement leads to some other problem, so with increased circulation and evaporation, due to the installation of baffles in calandrias as well as forcing the evaporators, heavier entrainment develops, especially on low types of effects. Entrainments naturally increase in proportion to the evaporating rate of the evaporators and pans, so that the loss in an efficiently operated evaporator, with short or low vapour spaces, becomes large. Most occurs in the last evaporator cell and can be detected by making tests of the condenser water.

We have automatic sampling devices on all our condenser water-legs which are checked every hour, using the alpha-naphthol test. If sugar loss can be detected in the water carried away by the condenser water-legs, the loss will be quite high, and save-alls should be installed. Our evaporators are equipped with 8 Wyllie improved type save-alls, installed in the inside of the dome of each cell, and 4 of the outside type, one on each third and fourth cells on A and B evaporators.

On vacuum pans there is a save-all installation of the same type and one Mirrlees Watson type on the fifth pan, eliminating inside save-alls entirely on all vacuum pans. We have experimented with ¼-inch mesh wire screen installation in the top of dome with the result that in one month the screens in third and fourth cells gradually sealed causing restricted area. Entrainment increased so rapidly that the screens had to be removed. On new installations vapour belts are now made 12 feet high from top tube-sheet to base of dome. The last cell should be kept even higher and with save-all installation on the inside of domes on all cells and outside save-alls on vapour lines on the third and last cells, entrainment will be entirely eliminated.—(*The Inter. Sugar Journ.*, Vol. XXXIV, No. 406, p. 403.)

(2) *Journ. Ind. Chem.*, 1918, p. 103.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

COLLEGE NEWS BULLETIN

JANUARY, 1933.] [No. 1.

One more year has gone during which the activities of the College and of its past and present members have been recorded in the Bulletin. We still lack, however, information from old students, and we should like to remind them once again that we shall always be glad at any time to receive their letters. While eagerly awaiting more news, we take this opportunity of extending our warmest greetings and best wishes for the New Year to all our readers.

COLLEGE NEWS.

Mr. G. Evans, Principal, returned to Trinidad by s.s. *Ariguani* on 18th September.

* * *

Dr. H. R. Briton-Jones, Professor of Mycology and Bacteriology, arrived on 20th September by s.s. *Colombie*.

* * *

Mr. W. A. Tansley, Bursar, sailed for England on four months' leave by s.s. *Magdalena* on 25th October.

* * *

Mr. P. E. Turner, Lecturer in Chemistry, returned to Trinidad on 28th October, by s.s. *Ariguani*.

* * *

Mrs. F. B. Carmichael, Assistant Librarian, returned from leave by s.s. *Crynssen* on 5th November.

* * *

Sir Edward Davson has been reappointed for a further period of four years as British Guiana's representative on the Governing Body of the College.

* * *

Mr. Cecil Hanbury, M.P., and Mr. Eric Macfadyen have been co-opted members of the College Governing Body for a further period of four years.

* * *

Mrs. G. Evans, returned to Trinidad by s.s. *Cavina* on 16th October. Dr. C. W. Wardlaw, Banana Pathologist, and Mrs. Wardlaw and child returned by the same opportunity.

* * *

Mr. L. N. H. Larter, a former student, after spending six weeks at the College sailed by s.s. *Carare* on 13th November to Jamaica where he will take up the appointment of Geneticist to the Department of Science and Agriculture.

The thanks of the College are due to Messrs. William Hunt & Sons: The Brades Ltd. for the presentation of a very fine collection of hoes manufactured by this firm and which are used in Brazil, Java, East Africa and the West Indies.

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Mr. G. A. Jones, Assistant Commissioner of Agriculture, and Mrs. Jones, Mr. G. Gianetti, Registrar, Librarian and Editor of the College Journal, and Mrs. Gianetti, Mr. J. G. Davies, Assistant Sugar Technologist, and twenty-six students arrived from England on 2nd October by s.s. *Carare*.

* * *

Mr. E. E. Cheesman, Professor of Botany and Genetics, Mr. D. D. Paterson, Lecturer in Agriculture, and Mrs. Paterson and two children, Mr. F. W. Urich, Assistant Professor of Entomology, Mr. E. E. Pyke, Botanist to the Cacao Research Scheme, and Mrs. Pyke arrived by s.s. *Ariguani* on 18th September.

* * *

Recent visitors to the College included His Excellency Sir Edward Denham, K.C.M.G., the Governor of British Guiana; Senor Carlos Arnaldo King of the Instituto Agronomico Campinas, Sao Paulo, Brazil; Mr. S. Di Giorgio of New York, of the well known Fruit Growing Farm; Mr. A. N. Duckham of the Ministry of Agriculture in Great Britain; Mr. John Easton of the Glasgow University Press; Mr. M. A. ap Rhys Pryce, who is interested in the production of castor oil; Mr. A. S. Cooper, the railway expert who is on an official visit to the Trinidad Government; Mr. C. A. Van Rensslaer of Holland; Mr. K. S. Burlingham of New York; Capt. W. Parry Okeden of Grenada; Hon. E. A. Keeling, His Majesty's Minister Plenipotentiary to Venezuela; Mr. A. de K. Frampton, Agricultural Officer of British Guiana; Mr. Frank Mansfield of the well known Liverpool Engineering

firm paid a visit of about a week's duration and was good enough to advise on the operation and method of working of the College Gas Producing Plant.

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COLLEGE SESSION 1932-33.

The 1932-33 College Session commenced on 3rd October, 1932, with the following students in residence :—

1st Year. *Diploma Students.*

Duncan, S. (Antigua); Bancroft, R. S. and Seale, C. C. (Barbados); Hassan, M. S., Hugh, E. D., Lee, W. L. and Wan-Ping, A. V. (British Guiana); Wyatt, A. E. (British Honduras); Wigley, C. G. (Dominica); Tai, E. A. (Jamaica); Yearwood, R. D. E. (St. Kitts); de Meillac, P. G. and Lai-Fook, C. (Trinidad); James, H. M. (England).

2nd Year.

Herbert, A. D. (Barbados); Garces, A. (Colombia); Cooper, St. G. (St. Lucia); Darwent, B. B., Ferrer, V. O., and Imamshah, C. M. (Trinidad).

3rd Year.

Miller, H. C. and McEwen, J. M. (Jamaica); Barcant, M. M. and Potter, T. E. K. (Trinidad).

Colonial Office Students.

Baker, R. E. D., B.A. (Cantab.).
Ball, R. S., B.A. (Cantab.).
Burgess, C. H., B.Sc. (Melbourne).
Freeman, W. E., B.Sc. (London).
Halcrow, M., B.Sc. (Edinburgh).
Kerkham, R. K., B.A., Dip. Agric. (Cantab.).
Kettlewell, R. W., B.Sc. Agric. (Reading).
Lamb, J., B.Sc. (London).
Pritchett, E. G. D., B.S.A. (Guelph, Canada).
Stewart, D. F., B.Sc. (St. Andrews).
Thorpe, H. C., B.Sc. (London).
Webster, C. C., B.Sc. Agric. (Wye).
Whitelaw, D. G., B.Sc. (Reading).
Williams, E., B.Sc. Agric. (Aberdeen).

Empire Cotton Growing Corporation Students.

Butler, E. J., B.A. (Dublin).
Marshall, J., B.Sc. (London).
Shearer, E. J. M., B.Sc. Agric. (Edinburgh).
Wight, N., B.Sc. Agric. (Edinburgh).

Special Students.

Bally, R. (Martinique).
Cameron, C. (British Guiana).
Campbell, B. P., B.Sc. (Louisiana).
Cofie, J., B.Sc. Agric. (California).
Coombs, A. V., Dip. Agric. (Wye).
Milburn, O. S., B.A. (Oxon).
Toms, K. E. (Amani Institute).
Torto, J. O., B.Sc. Agric. (California).

AN APPRECIATION.

Mr. R. E. Hunter, M.Sc.

Mr. R. E. Hunter, Lecturer in Botany, resigned his post in August, 1932.

Studying at University College, London, Mr. Hunter took his B.Sc. degree with Honours in Botany in 1924, and was subsequently Demonstrator in Botany in the Department of Agriculture, University of Leeds, arriving in Trinidad, on appointment to the Imperial College of Tropical Agriculture, in November, 1926.

His duties largely concerned Diploma students, of whom six successive classes will remember him as a stimulating and painstaking teacher, but he had other important responsibilities in the routine of the Department to which he belonged, and of which on three occasions he acted for considerable periods as Head.

At the same time he found opportunities for research, and had a wide range of interests. In particular, he devoted much attention to the physiology and propagation of Citrus species, and after many set-backs succeeded in establishing a technique for rooting single-leaf cuttings which is an especially promising contribution to the solution of some Citrus problems, and to the advancement of propagation methods in general. For a thesis embodying certain phases of these researches on Citrus, the degree of M.Sc. was conferred on him by the University of London in 1931.

Mr. Hunter married in February, 1928, Miss Winifred Mottram, herself a keen botanist and Honours graduate of University College, London. Mr. and Mrs. Hunter have now settled in Oxford and are both engaged in research in the School of Botany, Oxford University. The best wishes of his colleagues on the Staff of the College, and of their friends in Trinidad generally, go with them both.

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TRINIDAD SCIENCE CLUB.

THERE have been three meetings of the Trinidad Science Club this term. On 20th October, Mr. J. J. C. Buckley lectured on "Some Tropical Tenants of Man". This address, which was well illustrated by lantern slides dealt with the life-history and habits of the more important human and animal parasites. On 17th November, Dr. J. L. Pawan delivered a very informative address on "Bat Rabies". On 15th December, Mr. H. Bruins-Lich, Curator of the Botanic Gardens, lectured on "St. Helena".

AGRICULTURAL EXCURSIONS.

Every Wednesday during the Michaelmas Term was devoted to a field excursion, during which, as a rule, subjects or crops that were being dealt with in the lecture room or laboratory were further discussed under field conditions.

On the 12th October, a visit was made to the North Woodford Lodge estate where some of the cane fields were being attacked by froghoppers (*Tomaspis saccharina*). Although these fields were not badly affected, sufficient of the third brood was in evidence to illustrate the activities of the insect in all its stages. Natural control was exemplified by the abundance of the green muscardine and empusa fungi which were rapidly getting the upper hand in this brood. So far as its depredations are concerned, this particular species of froghopper is confined to Trinidad. The campaign for its control has, however, been so prolonged and intensive and has been approached from so many angles, that it is obviously an admirable example of the kind of problem that is usually encountered by Agricultural, Departmental and plantation officers.

The usual preliminary visit to the Government Stock Farm at St. Joseph was made on the 26th October. The dairy herd was first of all inspected. There are two main herds—one of Holsteins imported from Canada and another of Zebus largely of the Nellore breed. The European breed is of course famous for its milk yield but is not hardy under tropical conditions, whilst the Zebu is very well suited to the tropics but is of poor milking capacity. The experiments that are being made to raise a new breed of tropical dairy cattle by combining the good qualities of both breeds is being watched with interest. At present there are several groups composed of cows of various grades, and it is hoped in a few years' time to have definite evidence on the degree of Indian blood that may be essential if a breed hardy to the tropics is to be successfully evolved. Other matters discussed during the visit were the preparation, distribution and storage of milk in the tropics, and the care and management of equines and small stock.

On the 2nd November, Arcadia Estate in the Caura Valley was visited to see the coffee harvest. Mr. H. Rapsey was good enough to explain the estate system of cultivating, harvesting and preparing this crop. In Trinidad, coffee is grown as a subsidiary to cacao, and Mr. Rapsey is a firm believer in cultivating the Arabica variety. In other parts of the Island on the flatter lands Robusta is grown. Coffee has increased in area in recent years and there is now an exportable surplus. Dr. Briton-Jones gave a practical demonstration of the different methods of training and pruning coffee which was followed by a discussion on coffee pests and diseases.

On the 9th November a demonstration of spraying and dusting apparatus was staged at the College where there is now a good collection of machines, recent additions including valuable gifts of new types from Messrs. The Four Oaks Co. and Messrs. Cooper Pegler & Co., Ltd.

Rice was the crop dealt with on the 16th November, and the College plots and peasants' fields in the Caroni rice area were visited.

Arrangements had been specially made by Professor Wood to demonstrate the puddling of land, the preparation of seed beds and transplanting. The results of seed selection were obvious by comparison with cultivators' plots in the neighbourhood. Although a fair area is grown in Trinidad, rice is not a crop of major importance. It is not a plantation crop but is essentially one for the small holder and is very popular with the East Indian community. The College is fortunate in having this rice cultivation available, since paddy is one of the two most important cereals in the world.

The 23rd and 30th November were devoted to field days on the College estate, when post-graduates were given the opportunity of explaining and elaborating the field problems on which they were engaged. These occasions afford ample opportunity for criticism and discussion and are valuable to the demonstrator in that they tend to develop his confidence.

G. E.

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RECENT CONTRIBUTIONS.

The College is greatly indebted to Messrs. Tate and Lyle, Ltd., who have contributed £250 a year for a period of five years towards the maintenance of the College Instructional and Experimental Sugar Factory, to Messrs. C. Czarnikow, Ltd., for a contribution of £50 a year for a similar period, and to Messrs. Chapman and Hall, for a sum of £100.

SPORTS.

Past students will be glad to hear that this year's Rugby XV is probably the best we have ever had. Not only have all the matches played to date been won but each victory has been secured by a substantial margin. The College line has only been crossed once and that, during the match against British Guiana whom we beat, after a very good game. The team owes its successes to an exceptionally brilliant three-quarter line backed by a fast and skilful pack of forwards. In all the matches played so far the three-quarter movements have been delightful to watch, the handling of the ball being particularly good. The XV is fortunate in having a very nimble scrum-half, a fly-half and inside three-quarters who seem always to be able to find holes in the defence, and a Captain who, as a very fast and elusive wing three-quarter, has so far been largely responsible for the scoring.

Great keenness on the game has been shown throughout the term and this has been exemplified by all the members of the team turning out regularly for practice.

Match Results.

Played 9. Won 9. Points for 230. Points against 12.

Date.	Opponents.	Results.	
13th Oct.	Caribbeans	..Won	18-0
20th do.	Trinidad Northern	..Won	11-4
23rd do.	Trinidad Southern	..Won	40-0
27th do.	Trinidad Northern	..Won	35-0
5th Nov.	Caribbeans	..Won	40-0
18th do.	British Guiana	..Won	19-8
24th do.	Caribbeans	..Won	25-0
1st Dec.	Trinidad Northern	..Won	24-0
10th do.	Trinidad Northern	..Won	18-0

The prowesses of the Rugger team have in a way overshadowed all other forms of sport. The Soccer XI have acquitted themselves fairly well, although they have been knocked out of the League competition. The XI have to date played five matches of which two have been won, one drawn and two lost.

This year the College has joined the local Tennis League and turned out a team of five (two pairs and one singles' player) once a week for the past two months. The team have much enjoyed their matches and are getting a lot of practice which they hope to make use of in the forthcoming Island tournaments. Two very enjoyable Staff *vs.* Students tennis matches have been played, both of which were (of course!) won by the Staff. There may be another story to tell when the annual cricket and hockey fixtures have been played!

G. G.

OLD STUDENTS' CORNER.

J. DE LA BASTIDE (1929-1932) was appointed Chemist to the Usine François Robert, Martinique, at the beginning of November.

* * *

We offer our heartiest congratulations to C. W. L. Fishlock (1928-29) who was married at Caversham on the 4th November to Miss Dorothy Seymour. Fishlock will resume his duties in the Department of Agriculture, Uganda, early this year.

* * *

R. J. A. LEVER (1929-30) is stationed at Tulagi, British Solomons. He has found three insects new to science, two small moths and a leaf beetle, and says that the natives are very interesting, there being over forty distinct languages.

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J. C. EYRE (1930-31) who is in the Mwanza district of the Tanganyika Territory is Assistant to the Senior Agricultural Officer. Most of his work at present appears to be of an administrative nature. He informs us that "Jock" King (1930-31) is at Morogoro and that he met H. B. Stent (1930-31) in Cape Town. Stent who looked flourishing was then on his way to Northern Rhodesia. He also saw M. F. Rose (1930-31) and J. D. Jameson (1930-31) when they were on their way to Barberton.

* * *

R. P. DAVIDSON (1929-30) who is stationed at Lira, Lango District, Uganda, will be on leave early this year. The Lango District, according to him, is fairly large, both in area and population, and has an experimental farm of 50 acres. He likes his work. The main crop is cotton although ground nuts, sim-sim and various food crops are grown at the farm for experimental purposes and for seed production. He has seen something of H. L. G. Milne (1929-30) and Mrs. Milne, whom he says are both very fit, and H. R. Hosking (1927-28). He reports that A. J. Kerr (1929-30) is in Bugishu and that W. J. Badcock (1930-31), spent a month with him. Both Badcock and W. J. Irving (1930-31) are at Bukalasa. G. Griffith (1929-30) is working in the laboratory at Kampala.

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BIRTHS.

AKHURST (1929-30): On November 12th, 1932, at Kuala Lumpur, Federated Malay States, to Georgina (*née* Work), wife of Cyril G. Akhurst—a son.

WIRSHING (1928-31): On November 25th, 1932, Puerto Rico, to Mrs. J. A. Wirshing—a daughter.

Printed by the Government Printer, Trinidad, B.W.I.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

A.I.V. Silage.

In *Technical Communication* No. 1, published by the Imperial Bureau of Animal Nutrition, a description is given of the A.I.V. method of preparing silage. This communication has been reprinted in the *Scottish Journal of Agriculture*, Vol. XV, July, 1932. The method was worked out by Dr. Arturri I. Virtanen, Director of the research laboratory of Valio, the large Finnish co-operative dairy organisation, and its name is derived from his initials.

Virtanen started from the assumption that the conservation of green forage without noticeable loss is possible only when the splitting up of the nitrogenous material by enzymes is completely prevented. He found that this condition is attained if the acidity is kept below pH 4 by the addition of acid, and the maintenance of the correct acidity is the essential feature of the process. Though it is generally known that hydrochloric acid plays the chief part in the process, a mixture of acids, termed the A.I.V. solution, is used, the composition of which has not been divulged.

The standard type of A.I.V. silo is circular in shape, 16½ feet in diameter, and five feet deep. A smaller type, three metres in diameter, is recommended for farms having less than 15 cows. The pit is compactly filled with fresh, unchopped fodder, in lots of about 450 lb., an exact quantity of the A.I.V. solution being added after each lot, and air is excluded by an impervious covering. As a protection against mildew, a very dilute solution of allyl mustard oil is sprinkled on the top layer of fodder. The food is ready after about two months, and practically no loss of nutritive value is found to have taken place. Certain factors may cause failure, such as water collecting at the bottom of the pit, insufficient trampling during filling, or the use of material which is not quite fresh. The mature silage is rather moist and has a sweet and slightly acid taste, but it is readily consumed by animals, even in preference to turnips. Figures are quoted to show that the true protein and soluble albumen contents of Timothy grass and clover are practically the same in fresh and ensiled samples.

Extensive feeding tests have been carried out by Virtanen over several years in order to test the feeding qualities of the silage. In general, it appears that the normal daily ration for milk cows of average yield is about 90 lb. A.I.V. fodder, plus three ounces chalk and one and a half ounces sodium carbonate. No digestive disturbances have been observed, and the milk has not the peculiar taste which occasionally results from the use of other types of pressed fodder. Butter has the rich yellow colour of summer butter, and the milk is well suited for the more acid cheeses.

Debarking and Degumming Ramie by Chemical Means.

Although ramie has long been known and discussed as a possible textile fibre, it has never assumed a position of importance in this field, mainly because the cost of the fibre is comparatively high. From the grower's point of view the crop is attractive. It propagates from the roots, is free from pests, yields very heavily, and matures evenly as straight unforked stems, 0.25 to 0.5 inch in diameter and varying from 4 to 6 feet in height. In the East the green wet stalks are stripped and the bark removed by hand, and when dried this material is the China grass of commerce. Attempts to strip and debark by machinery do not seem to be commercially successful.

Preliminary study of stripping indicated that the bark and fibre bundles can be removed from the stalk only when the gums are completely softened by soaking in water, or when they are rendered brittle by air-drying. Treatment of small samples of dried ramie with various reagents indicated that even at atmospheric pressure and moderate concentrations most of the materials removed the gums and softened the fibre, but in all cases the fibre was ruined for any practical purpose. Ultimately it was found that 50 grams of crude fibre in 2 litres of a one per cent. solution of ammonia and sodium sulphite, digested at a pressure of 60 lb. per square inch, was completely debarked in 4 hours, and could be degummed by digestion with soap, and bleached. Experimental work is now being carried on to provide exact cost figures for the process.—(*Ind. and Engin. Chem.*, Vol. XXIV, 1932, No. 10, p. 1162.)

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Bamboo Artificial Silk.

Experiments are being made at the Forest Research Institute at Dehra Dun, India, to produce art silk from bamboo pulp, and it is understood that partial success has already been attained.

Cellulose was prepared from *Ochlandra travancoria* (*eta* bamboo) conforming to the specifications demanded by the artificial silk industry, but the preparation fell short to some extent of the necessary requirements. The maximum percentage of α-cellulose, which is the most important constituent in cellulose for the manufacture of artificial silk, is only 89-90 in bamboo pulp; the percentage of ash in bamboo pulp is also high, *i.e.*, 0.3 per cent as against 0.1 per cent to 0.2 per cent, the maximum required in cellulose for artificial silk.

Further experiments at the Dehra Dun Forest Research Institute are in progress, from which it is confidently hoped that it will be possible to attain the necessary high percentage of α-cellulose and also to reduce the ash percentage. The successful solution of the problem would encourage the establishment of a new and important industry in India and provide an additional outlet for the utilisation of bamboos. (*J. Soc. Chem. Indus.*, Vol. LI, No. 42, 1932, p. 864-865.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows, c.i.f. per cwt.):

	Foreign.	*Preferential.*
	s. d.	*s. d.*
27th Oct. ..	5 9	10 6
3rd Nov. ..	5 9¾	10 7½
10th Nov. ..	5 10½	10 7½
17th Nov. ..	5 9	10 6
24th Nov. ..	5 9	10 6
1st Dec. ..	5 4½	10 1½
8th Dec. ..	5 5¼	10 3
15th Dec. ..	5 0¾	9 10½
(*10th Dec.*, 1931) ..	6 9¾	10 6¾

Sugar continues to yield to the general depression which surrounds almost every field of commercial activity and although values have been maintained in the United Kingdom, the trend in America has shown a definite tendency towards lower levels, quotations for "futures" and "actuals" registering declines. No change, however, has occurred in the fundamental position of the article, which in any way affects its comparative soundness statistically. On the contrary, possibilities of a fairly large reduction in output shown in the recent new crop estimates, Cuba's intention of adjusting her output and exports to world needs and Java's plans for securing complete control of her industry, should eventually exert a beneficial influence on the sugar position as a whole.

* * *

COCOA.—A dull tone in the cocoa market has prevailed since last writing and values of Gold Coast with slight fluctuations are lower, with business done in good fermented in c.i.f. terms for December-January shipment at 26*s.* 3*d.* to 25*s.* 3*d.* closing at the latter figure. The spot market has been quiet, values where any change is noticeable being in buyers' favour. In Trinidad the market may be quoted at $6.40 a fanega. —(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

* * *

TEA.—Latest averages per lb. include Ceylon at 11.34*d.*; Indian at 8.26*d.*; Java at 6.34*d.*; Darjeeling 15.33*d.* and Nyasaland 6.41*d.* Prices rose steadily until the beginning of November when they showed a tendency to decline.

* * *

COFFEE.—Prices of Coffee have been rather favourable to buyers of West Indian and have been moderate for East African; Costa Rica is quoted from 65*s.* to 85*s.* a cwt., Rio at 59*s.* 3*d.* c.i.f., Kenya from 67*s.* to 105*s.*

COPRA.—Has been a steady market and West Indian f.m.s. is a little higher at £15 2*s.* 6*d.* spot, and £15 5*s.* forward.—(*West India Committee Circular*, 24th November, 1932.)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
28th Oct. ..	5.62	7.80
4th Nov. ..	5.39	7.76
11th Nov. ..	5.60	7.99
18th Nov. ..	5.61	7.70
25th Nov. ..	5.44	7.56
3rd Dec. ..	5.14	—
10th Dec. ..	5.14	—
(*4th Dec.*, 1931) ..	5.14	7.20

The American Cotton Market for the past month has, on the whole shown a steady front. It reacted well in the face of the large increase shown in the Bureau crop report. The latest quotation for West Indian Fine is 6.35*d.*

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	d.
26th Oct.	2½
2nd Nov.	2 15/32
9th Nov.	2 5/8
16th Nov.	2 19/32
23rd Nov.	2 19/32
30th Nov.	2 5/8
7th Dec.	2 9/16
14th Dec.	2 15/32
(*9th Dec.*, 1931)	3

The Rubber market has fluctuated within narrow limits. The uncertainties regarding the financial situation generally, and in particular as to the War Debts question has tended to damp any spirit of enterprise. Generally speaking there appears to be a somewhat more hopeful feeling regarding commodities on their own merits but any actual movement is held in check by the difficulties of the financial and political situation.

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BANANAS.—Jamaicas are in improving demand and prices have recovered to £18 15*s.* per ton delivered London, and £18 10*s.* nearest railway station.—(*West India Committee Circular*, 24th November, 1932.)

* * *

LIME PRODUCTS.—*Lime Oil.*—The small supplies of Handpressed are meeting a poor demand; the price remains unchanged at 45*s.* per lb. The sudden revelation of a really short supply in the principal producing islands has led to a rapid advance in the price of Distilled and up to 33*s.* 6*d.* has been paid on the spot. *Lime Juice.*—There is no market for Concentrated. Raw is unchanged; the latest price was 2*s.* 3*d.* to 2*s.* 6*d.* for good Dominica to fine Jamaica.—(*West India Committee Circular*, 24th November, 1932.)